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THE 12-INCH ZÜRICH TELESCOPE SET UP IN THE CONSTRUCTION SHOP.

THE URANIA-ZÜRICH EQUATORIAL TELESCOPE.—[See page 152.]

WHEN THE SUN IS EXTINGUISHED.

WHAT WOULD HAPPEN.

BY DR. M. WILHELM MEYER.

WHAT would we do if one of these days we should notice that the sun will rise no more?

The good housewife will answer: Well, in that case we shall simply switch on the electric light. And even if the sun should go on strike forever, our engineers, those magicians, who can do anything, would soon invent something to compensate for this loss. Has not engineering such a reputation nowadays, that nothing is believed to be impossible to it?

The scientist might add right here that nature has invented a light far cheaper than electric light, for instance that emitted by fire-flies. And if we have discovered so many of nature's secrets, why should not we fathom that of the fire-fly light? As regards the cheapness of such living lanterns, it is interesting to learn that American scientists have recently subjected a lightning bug which emitted a light equal to only 1/1,600 of a candle-power, to examination with exceedingly delicate instruments capable of measuring almost unbelievably small amounts of radiant energy. They found that this little beetle to produce its light, did not expend any amount of energy that they could measure. If this energy had been but one ten-thousandth of that necessary to produce illumination of the same brightness by means of a candle, it would have been measurable. The conclusion is that this insect's light is at least ten thousand times cheaper than candle light. All the engineers have to do is to invent it.

Economy, however, can be obtained only by avoiding the tremendous waste of heat common to all our sources of light. But we also need the sun's heat. It is true that at times the sun is rather free with his heat, and we flee from his too great liberality. At other times, however, we have to resort to stoves and furnaces. Should not it be possible to invent something that would insure a more even distribution? Could not we become independent of the sun's heat radiation? Do not scientists tell us that the interior of the earth is extremely hot, at least just as hot as the streams of lava pouring from volcanoes? Compared with this almost inexhaustible source of heat contained in the body of our good old mother earth, the few saved-up pennies represented by our coal beds are as nothing.

Perhaps this interior heat would suffice for a few hundred thousand years. After all, we could dig deeper and deeper into the earth in order to get nearer and nearer to the hot center of our planet. It is probable that the first human beings were cave dwellers who retreated before the ice of the glacial era into these open folds of the earth's crust, where at least a cellar's warmth was obtainable; why should not the last men do the same thing for a like reason, but in their own power and in a much more perfect way than their old-time predecessors? The huge heat stored in the earth's interior could be utilized readily for ample lighting, especially if we do invent the cheap light. We could build fairy-like underground palaces, sparkling with crystals and gems, resplendent in variegated luminous colors, with reflecting galleries of pillars and romantic stalactite structures. Comfortable heat and soft light, just as we should like to have it, would fill all rooms. We should walk in woods of trees made of polished, many-veined agate, and bearing leaves of silver and gold. The flowers at our feet would be rubies, sapphires, and topazes, and all the wonders with which our childhood's fancy adorned the fairy gardens, could there become a reality.

There still remains one doubt, however. Shall we not have to starve amid all this splendor? Up on the surface of the earth it has become cold and dark. But no plant can grow without light, and indeed they cannot do without sunlight. No artificial light has so far been able to take the place of the sun. All animals, and ultimately the human race, live on plants directly or indirectly. The conversion of mineral substances, water and air into edible products could hitherto be effected only by the plant organism in its microscopic retorts. This is another undiscovered secret.

But whenever dire need arose the saving discovery was made. At present we are still able to have the plants cook our food in sunlight, and this fortunate condition is likely to continue for quite some time. Still our shrewdest investigators have long ago begun attempts to make "organic substances," and ultimately bread, from stones or at least from air and water with a little bit of earth added. Some success has been achieved already. Unfortunately, everyone of the organic substances so far produced in the chemical laboratory has no nutritive value whatever. We have been able to reproduce artificially the perfumes of flowers, for instance the sweet fragance of the violet, which certainly is one of nature's masterpieces, and also many dyestuffs which heretofore could be derived from plants only. So far, however, there is among these artificial products none of any use to our stomachs. But all this will be achieved some time, and then we shall not need the sun at all, and it may go out if it wishes.

But will this ever occur? Can the sun ever lose its immense power? A calculation has been made showing that the sun is like a furnace capable of heating an engine that could every second lift a load of 30 billion tons (of 2,000 kilogrammes each) a distance of one kilometer. Let the engineers figure what they could do with this, whereas at present they allow all this energy to go to waste. With an infinitesimal portion of this energy the sun sets in motion the machinery of our atmosphere which raises the water from the seas to the clouds and feeds our waterfalls. With small tappings of this water, such as those diverted at Niagara Falls, we light entire cities. This furnace, as could be determined with reasonable certainty, has a surface temperature of about 6,000 deg. C. In its interior the sun must harbor temperatures of perhaps hundreds of thousands of degrees. And from this sun there might be formed more than 300,000 bodies of the earth's size, all of this tremendous heat. It will be apparent that this represents a huge store which is likely to last many millions of years. A rough calculation showed that the sun has been shining upon this earth for about 500 million years and that it ought to continue doing so for another 100 million years, but it must be admitted that these figures rest on insecure foundations. But even if they are ten times too large, we can await developments with some equanimity.

Even nowadays we see signs indicating that some time sunshine and sunbeams will cease. On the sun's beautiful face traces of old age will appear now and then as dark spots which break out in greater or smaller numbers and extent, often suddenly, at other times requiring weeks and months for their development and disappearance. About every eleven years these ugly pock marks break out with particular strength on the brilliant skin of the mighty ruler of our world, every eleven years his body must rid itself of this bad disease, whereupon for a few years the sun may beam again with almost spotless purity and again spread happiness and comfort everywhere with bounteous plenty.

These sun spots are violent whirlwinds in the upper atmosphere regions of the central body of our planetary system, as is evidenced by the very shape of the cloud formations, frequently spiral and storm-swept, which surround the inner apparently quite black nucleus of the spot. Recently the American astronomer Hale, who has made a special study of the sun, has particularly investigated the spectral lines into which the light of the sun spots may be separated, and has shown that in these cyclones there occur tremendous electric discharges the effects of which we may often observe upon the earth in the magnificent polar lights which are frequently seen shooting up when an unusually large sun spot faces the earth. The sun clouds which are whirled about in these frightful thunderstorms are frequently so large that the earth's entire surface could be contained in them many hundreds of times, and so hot that iron would be not only liquefied, but transformed into vapors. As a matter of fact it is partly iron air which blows across the surface of the sun and from which a rain of luminous drops falls in the spots, to be again gasified in the lower, hotter strata of the sun and to whirl up from them.

It has been observed that whenever the sun is covered with particularly numerous spots the whole atmosphere of the earth grows cooler one or even two degrees (centigrade). It has further been found that a temperature reduction of only five degrees would suffice to bring back the glacial era in our latitudes, destroying every vestige of life in streams of ice a thousand meters thick.

We therefore really cannot deny that the sun already begins to slowly lose its light. Among the countless fixed stars in the skies, all of them distant suns, there is a large number which periodically lose their light and therefore their heat in a much higher degree; these are called variable stars. Some of them are known to change their light by all sorts of gradations; some require almost as much time for the change as our sun, others become alternately bright and dim within a few hours; some have perfectly regular fluctuations, others flare up and grow dark again without any regularity; some vary but little in magnitude, others may pass from absolute invisibility to the greatest brightness, and then vanish again into the night of the universe.

In the same manner, after many fluctuations of this character, our sun will some time have lost all its light and all its heat. But long before this shall have happened, the last glow will have become extinguished in the earth's interior, and with it all life on this dark little star which has been assigned to us as a dwelling place. At the last extremity there will be an absolute failure of all the clever tricks and inventions by which we were able to impress nature into our service in order to keep away from us, for a time, the life-chilling power of the increasing inter-stellar cold, which is bound to grip us more and more. In a like manner all those projective devices must finally become exhausted which nature herself has invented for the wonderful organization of the universe, to save her creatures as long as possible from the fate of freezing to death. I have discussed this at greater length in the revised edition of my work on "The End of the World," published in the "Kosmos" series.

But only each particular world or world system, as an individuality, can perish. Everything must die in order to make room for the birth of something better. The end of a world is followed by a new creation. There is an everlasting cycle of life and death, back to new life.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Die Gartenlaube.

WESTWARD MIGRATION OF EARTHQUAKES.

A VERY interesting theory concerning the apparent westward migration of seismic and volcanic activity has been lately published by H. Wehner, according to Prometheus. According to this view, the earthquakes, which apparently appear quite sporadically in weak parts of the earth's crust, are subject to a regular law of distribution. From the examination of numerous lists of earthquakes and volcanic eruptions, Wehner concludes that the tendency to these convulsions move slowly from east to west in every part of the world. From the center of the disturbance this tendency moves westward on the same parallel of latitude, with a velocity of about 22 minutes 41 seconds of longitude per year, thus making the circuit of the globe in 952 years. At any place of instability, the danger of an earthquake or volcanic eruption is increased when this migrating tendency to disturbance reaches the spot.

Wehner cites a number of examples to prove the truth of his theory. The earthquake which occurred in 1855 in the vicinity of the Sea of Marmora should have been followed, according to this theory, by outbreaks at weak points lying further westward on the same parallel of latitude, after the expiration of various periods of time. The Gulf of Naples is a weak spot in the earth's crust, 14½ degrees west of the Sea of Marmora; hence an earthquake might have been expected there thirty-eight years after the Marmora earthquake, or in 1893, in which year a violent earthquake actually occurred at Naples. Similarly, from the earthquake of 1880 in Smyrna are deduced the earthquakes of Chios in 1881, Athens in 1886, Corinth in 1888, Zante in 1893, the Ionian Sea between 1893 and 1905, and the great Messina earthquake of 1908. Future shocks of the same series may be expected to occur in 1914 at Palermo, in 1952 at Alicante, and in 1972 on the coast of Portugal. In this series the great earthquakes of Smyrna, Zante and Messina are of special influence. At present there is an unusual danger of earthquake in the vicinity of St. Etienne and Herault in France, in Macedonia, Otranto, Tarentum, Cyprus, and portions of Algeria. This theory is based upon the hypothesis that the kernel of the earth is rigid, and rotates less rapidly than the crust of the earth, and that certain inequalities upon the exterior of this rigid kernel increase the local tendency to earthquakes. This hypothesis is not accepted universally, and it yet remains to be proved that the asserted law of progression will actually suffice.

CROCODILE REMINISCENCES.

LOCAL TALES AND SUPERSTITIONS.

BY A. CAVENDISH.

FISH and dog stories we all know, and are accustomed to swallow with "salt to taste;" but it is only given to those whose path lies off the beaten track to hear, first hand and in the vernacular, the inevitable crocodile stories with which the river dweller of the Eastern tropics likes to regale his white guest, sitting smoking long native *rokos* in the semi-darkness during the hour between the evening meal and bedtime.

What the fish and dog story is to us, so is the crocodile story to the jungleman. He even goes further. He ascribes to the crocodile supernatural powers; he surrounds him with a halo of romance; he propitiates him with periodical offerings, and when diplomacy fails, he declares war to the death—war lasting perhaps for years, till some trifling occurrence is construed into a sign of surrender on the part of the crocodile, and all is peace again.

Wonderful indeed, and hard to believe, are some of these native stories; but the majority of them are true for all that, though the fascination and glamor of them fades when the smooth, musical Malay tongue is changed for matter-of-fact English, and the flickering glimmer of the *damar* torch on palm-leaf walls is replaced by the lamp and writing table of civilization. For these reasons I have confined myself to recounting a few of my own personal experiences, in which, I fear, the crocodile figures, not as the native reads him, but as I have found him—savage, crafty, and loathsome to the last degree.

But to begin at the beginning. My first experience of the "river king" was many years ago, when circumstances compelled me to travel for several hours in an extremely rickety and dilapidated dug-out along a tortuous and stagnant, mangrove-lined creek. I had not been long in the tropics, and my great wish was to see—and, if possible, to shoot—my first crocodile. In the dug-out with me were my Chinese "boy" and the ancient owner of the craft—who, by the way, supplied the motive power with a paddle, while all my energies were directed toward keeping my balance and postponing the catastrophe of an upset, which each moment appeared more imminent. After an hour or so, when familiarity had bred contempt, and I was at length emboldened to stretch my cramped limbs and find a new and more comfortable position, I inquired of my venerable Charon whether there were any crocodiles in the creek. The old man, going as near to a chuckle as a Malay will allow himself to do, replied that I need not be afraid; that there *were* crocodiles, but that they were kindly beasts who never interfered with human beings. Feeling somewhat hurt at my inmost thoughts being thus probed, I relapsed into silence and a cheroot, and was momentarily growing more drowsy, when a remark from the old native brought my thoughts back to earth with a start. "*Itu dia*, there's one," he quietly said, pointing with his mouth, in the native fashion, toward a tangle of mangrove roots and rotting vegetation, while his paddle rose and fell with unaltered speed. "There's one." I looked, I gazed and peered among the mottled shadows, but nothing could I see that in any way resembled my idea of a crocodile. "Where?" I asked; and then it happened. My Chinese "boy," ever anxious to please, had grabbed a piece of wood that was floating by, and hurled it violently at the spot indicated by the native. The next half minute was chaos. In my anxiety to see the crocodile I had raised myself up, and the lurch caused by the rash act of my servant in throwing the piece of wood made me lose my balance. I collapsed (luckily into the boat), some gallons of water came in over the side, and the old man at the stern, steadying the canoe with the quiet, instinctive movement of one who knows his business, muttered the one word, "*Bodah!*" (Idiot). As I struggled once more to a sitting posture I saw a long black object, which I had taken to be a log, glide noiselessly into the creek, hardly raising a ripple as it vanished, and I caught a glimpse of two beady, cruel eyes, which seemed to look greedily at me as they disappeared below the slimy water. I had seen my first crocodile; but whether the old man's last muttered comment was directed toward me or my servant I have never discovered, nor did I then feel inclined to ask. In either case it was richly deserved. This was many years ago, and though since that day some dozens of the loathsome reptiles have fallen to my rifle, I have never forgotten the look of malignant hatred and concentrated evil shot at me from those yellowish-green eyes.

From past to present is but a step for the memory, and it is only a few months since the incident happened that I am about to relate. My work took me on a visit up a river to one of those timber-cutting camps where are felled and rafted the great hardwood logs so valued in the Chinese market. G., the white man in charge, was a characteristic old "hard case," who had started life before the mast in a sailing ship, and drifted in a beach-combing fashion to our colony, where he had been given, almost in charity, a subordinate billet in one of the large timber companies. Arriving in my boat at the little jetty or landing stage, I was astonished to find G. lying on a rattan couch within a few yards of the bank, with a heavy express rifle across his knees, gazing intently at a rough *pagar* or fence erected in the stream. Hanging from this fence, and a few feet above the water, were the corpses of a monkey and several pariah dogs, while half a dozen ducks, each tied to the fence by the leg with a long string, flapped about on the water and quacked dismally in their efforts to escape. I was just wondering whether the whisky bottle or too much solitude accounted for this state of affairs, when I noticed that G.'s leg was swathed in rough bandages from knee to ankle. Throwing myself down near him in the welcome shade, I learned the following story: Two nights before G. was sleeping peacefully in his little palm-leaf house, in a clearing about twenty yards from the river bank, when his dog began to growl and refused to be silenced. G. turned out and walked around the hut to ascertain the cause of the disturbance, but seeing nothing, addressed himself to the dog in his usual lurid and picturesque sailing-ship language and retired to bed again. Five minutes later he was once more aroused by a yelp from the dog, and this time really annoyed, he seized a stick and sallied forth to inflict dire punishment on the disturber of his dreams. Suddenly a dark form glided swiftly from the shadows, and G. felt himself seized by the right knee as in a vise. Stooping to free himself, he found he was in the grip of a large crocodile, whose teeth were firmly embedded in flesh and bone. Backward and forward the struggle swayed—the crocodile striving to pull its destined victim to the water's edge, and G., hampered as he was by his imprisoned leg, fighting for his life to reach higher ground. At last the beast, hurling its victim to the ground with a shake of its powerful head, began to drag him swiftly toward the water. Poor G., feeling, as he expressed it, that it was "all over bar the shoutin,'" determined to make one last effort for his life, and, taking advantage of a momentary halt as the brute was steering past a tree stump, he sat up and succeeded in getting both his thumbs into the reptile's eye-sockets—the only vulnerable part of a crocodile's head. The rest of the story is perhaps best told in G.'s own words, or as nearly as circumstances (and the Editor) will permit: "So soon as I gets my thumbs made fast in 'is eyes, 'e opens 'is mouth to shout an' lets go my leg. Then, first thing next mornin', the coolies lays 'is breakfast for 'im, as you see, an' I gets into this chair, an' 'ere I stays, if it's a month.' Vainly I tried to persuade G. to come away with me to the next station and see a doctor. I argued with him, I implored him, but it was absolutely useless. He refused to move from that chair till he had bagged his crocodile, and I was at last obliged to leave him, having dressed his leg and exhausted every known means of persuasion short of brute force. I met him again a week later lying in a hospital bed, suffering severely, but quite happy in the knowledge that the bones of that crocodile were bleaching in the sun outside his house. Poor old G.! Only a few weeks afterward the habit of clearing creepers from his path in the jungle with the butt-end of his loaded and cocked rifle, proved fatal to him.

Perhaps the most firmly engrained superstition in connection with the crocodile—if superstition it be—is the belief that the washing of a mosquito curtain in a river will be followed, within a week, by the death of some person in the village on its bank at the jaws of the crocodile. So implicitly is this believed that many villages take their curtains to some jungle pool or spring rather than even use water drawn from the river—this though the same persons will bathe and wash their garments actually in the river itself! The offender is usually some traveling Chinese trader, and, curiously, no less than four cases have come to my personal knowledge in which the washing of a mosquito-net in a river has within a week been followed by the taking of a villager by a crocodile. In one case nobody had been taken in the river for over a year; and in another case the wretched Chinaman was arrested by the zealous local policeman, himself a native of the district, and sent under custody to the nearest European magistrate, solemnly charged with causing death "by a rash and negligent act, thereby committing an offense punishable under the penal code."

An account appeared some years ago in the local papers of Singapore relating how the native hunting-dogs in that part of the world were so clever that, being desirous of crossing a river, they would first congregate on the bank and bark loudly to attract the crocodiles, and then run swiftly upstream and cross at another place. The tale was greeted with much editorial sarcasm, and commented on as "something new in dog-stories." A month or two later some incident recalled the story to my mind as I sat late one evening discussing the day's deer-hunting with an old chief, who himself owned the premier pack of pariahs in the district. I repeated it, as nearly as I could remember, to the assembled village, who with one accord sat silent, waiting for the words of wisdom to fall from the old chief. For some minutes he chewed his quid of betel-nut in a meditating way, and then broke out with the following explanation, which I give in his own picturesque phraseology: "Wherever there is smoke one must seek the fire. This is a true story that has passed through many mouths. The way of it is this. It is not the cleverness of the dogs, but of the owners. The men of my people, when chasing a deer on foot with dogs, are always careful in crossing a river, for the yelping of the dogs calls together the crocodiles. The dogs, therefore, are trained to stop at the bank and bark loud and long. The hunters then cross at a place some distance away, calling their dogs, who follow in their masters' footsteps. That is truly how the story began; but it has altered in the telling, and is now like a child's fable."

The very next day I had an opportunity of confirming this explanation, for a deer put up by my own dogs during my evening stroll made straight for a stagnant backwater of the river and plunged in, closely followed by my three yelping terriers, who swam around and around him, snapping at his back and sides as opportunity offered. Some village dogs, attracted by the din, came rushing up and joined in the chorus, but without attempting to enter the water. Standing on the bank I was whistling vainly to my dogs, when the deer gave an agonized scream and disappeared below the slimy surface of the pool, pulled down by some unseen foe, never to reappear, though I waited for a good ten minutes. When I left there was not a bubble nor a ripple to show what had taken place. But no explanation was needed as far as I was concerned; and my three terriers, following, cowed and shivering, at my heels, had learnt a lesson that they remembered for a long time; though two of them eventually fell victims to a similar fate.

I have discussed the habits and customs of the *buoia* or crocodile with many natives, and their solemnly delivered opinions would certainly open the eyes of any naturalist. The majority are firmly convinced that the beast has the power of fascination similar to that generally accorded to the snake, and they also believe that the crocodiles in any given river will not molest man unless man has first molested them. When recently being paddled up a small river for the first time, I was about to fire at a young crocodile lying on an exposed mud flat. "Don't, sir—don't!" cried the four paddlers as one man. I lowered my rifle and asked their objection. It appeared that in this particular river, though it swarmed with crocodiles, and the villagers habitually bathed there, nobody had ever been taken; while in the next river, debouching at almost the same spot on the coast, there was continuous and bloody strife between the natives and the crocodiles. This was corroborated by other villagers on the river, who ascribed their immunity to the fact that they had never killed a crocodile there, and in return the crocodiles had never done them any harm. Whether or not this can be accounted for on the theory that a crocodile "turns man-eater," like a tiger, is an interesting problem.—Chambers's Journal.

To Paint Cement Work.—When air dry, paint until white with a mixture of English sulphuric acid (not fuming), 1 part to 10 parts of water. Allow it to dry thoroughly and then paint with any oil or Japan paint.

MODERN FORTIFICATIONS.

THE PRINCIPLE OF THEIR CONSTRUCTION.

The history of fortification is as old as that of nations. New requirements, born of the incessant improvement of artillery, have modified its details, but its object remains the same as always: to allow the defender of a post to hold out against superior forces. For this purpose it is necessary to create an effective obstacle to the approach of the enemy, and also to provide shel-

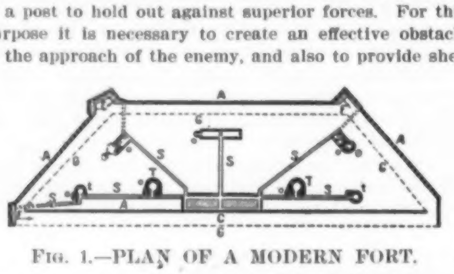


Fig. 1.—PLAN OF A MODERN FORT.

A, counterscarp of concrete 8 feet thick; G, barbed grills forming escarpment; C, barracks; F, flanking coffers; S S, underground passages; T t, gun turrets; a, fighting shelter.

ters in which the defenders may be protected from the fire of the enemy, while remaining free to use their own guns effectively.

Vauban inclosed a wide and deep ditch between two thick walls, the escarpment on the inner side and the counterscarp on the side toward the enemy, and we find these elements repeated in all the old forts, including those which were built in the reconstruction of the French system of defense after the war of 1870. The forts surrounding Paris are classical examples of this construction.

The New Principles of Fortification.—The newest forts present a totally different appearance. The ditch remains, but the huge earthworks of the old forts, 30 or more feet in height, have been abandoned as too vulnerable under the very accurate fire of modern artillery. In the most important French forts these great earthworks have been replaced by much lower but much thicker parapets, which are just high enough to give the defenders a good view of the surrounding country. The experience of the fort of Malmaison in 1886, following the introduction of highly charged torpedoes, proved that a thickness of at least 40 feet of earth is required to give certain protection against these terrible engines of destruction. Parapets of 45 or 50 feet in thickness are found in many of the newest forts. The ditch is constructed on a new plan. On the side toward the enemy, a counterscarp about 15 feet high is retained, but this is now constructed of cement concrete and is at least 6 feet broad at the top. By this construction the joints of ordinary masonry are eliminated, and the wall forms a homogeneous mass of remarkable strength. It is reinforced by a mass of broken stone, 10 feet thick, placed in front of it, which constitutes an obstacle to undermining by shells striking in front of the concrete wall and bursting underground. The escarpment on the inside of the ditch has entirely disappeared, in its original form, at least. Now the bank is allowed to have its natural slope from the firing line to the bottom of the ditch, and a strong grille of barbed wire im-

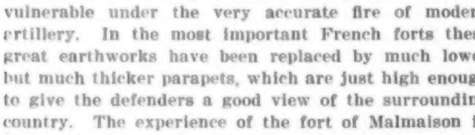


Fig. 2.—SECTION OF PARAPET AND DITCH OF A MODERN FORT.

A, fighting shelter; P, broken stone; G, escarpment grille; b, concrete; C, counterscarp.

bedded in concrete replaces the stone wall of the old type, which is too easily destroyed by persistent artillery fire. Finally, as the defender cannot see the bottom of the ditch from the top of the parapet, chambers of concrete with very thick walls, known as flanking coffers, are constructed at each end of the counterscarp. From these coffers the ditch can be raked by the fire of machine guns and other rapid-fire guns, driving away any enemy rash enough and skillful enough to enter the ditch. At present more than ever before, it is imperatively necessary to protect the defenders of the fort against bombardment, which now may be extremely effective. For this purpose, shelters are constructed beneath the parapet, with concrete walls 8 feet thick, and in these shelters the troops detailed for service on the rampart take refuge during the entire fire of the enemy. The remainder of the garrison is sheltered in barracks, also built of concrete and furnished with all the indispensable conveniences of daily life. All of these rooms, including the flanking coffers, the shelters on the ramparts, the barracks, the casemates, and the turrets described below, are connected together by a system of underground passages, through which the members of the garrison can circulate freely without being exposed to the fire of the enemy. Only a few sentinels keep watch on the ramparts, from armored lookout towers, for the purpose of giving warning of the enemy's approach.

Gun Turrets.—The precision of modern gun fire makes useless all unprotected pieces of artillery, which would naturally be the chief points of attack by the enemy. Hence the large guns, which were formerly placed in the forts, are now collected in batteries behind the line of forts, and the latter contain only very small numbers of guns, devised for special purposes. It is necessary for a fort to be able to constitute its own defense, and to protect to the last moment the guns which command an important point. These guns might be mounted in casemates of concrete with walls 8 feet thick, which would afford effective protection against the enemy's fire. The openings through which the guns would be fired must in this case be made extremely narrow, in order to avoid making them particularly vulnerable, but guns protected in this way could be fired only in a very small number of directions. The adoption of the revolving armored turret is a much more satisfactory although more costly solution of the problem. A gun turret consists essentially of a cylinder made of armor plates, revolving in a well lined with concrete, which contains the necessary machinery and magazines in addition to the guns and the gunners. The concrete walls which line the shaft

Fig. 3.—EARLIEST TYPE OF REVOLVING TURRET.

vary in thickness from 10 to 16 feet, according to the type of turret, and are protected, on the side toward the enemy, by a mass of broken stone and an earthwork at least 30 feet thick. In order to obviate the possibility of a shell striking the edge of the well and detaching fragments of concrete, which might fall between the wall and the turret and prevent the rotation of the latter, the mouth of the well is formed of a ring of hard cast iron, which affords additional protection, and which furthermore provides a way of communication around the turret. At first, a simple rotating turret was employed (Fig. 3). It consisted of an arched roof of hard cast iron, 16 inches thick, supported by a frame of steel plates about 1½ inches thick. The roof alone appeared above the massive concrete wall of the well. Hence a turret, carrying two 6-inch guns, offered a target only 3½ feet high and about 18 feet wide. The turret was turned by hand, by means of gearing, the movement being facilitated by raising the whole mass, by means of a hydraulic press acting upon the pivot of the turret, so that only 1/10 of the weight rested upon the wheels on which it turned, and the remainder was supported by the cylinder of the press.

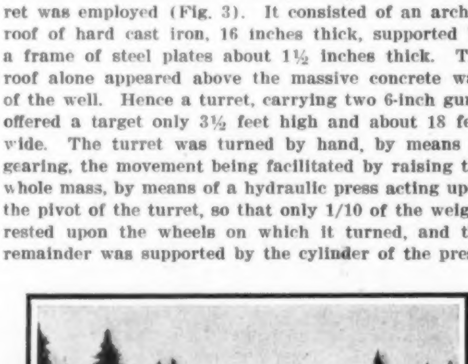


Fig. 4.—SECOND TYPE OF TURRET WITH GUNS PROTRUDING.

The increase in the use of armor and the continual improvement in artillery led to the construction of the second type of turret (Fig. 4) which is made of laminated iron and is much less visible. This was soon

Fig. 5.—TURRET IN DISAPPEARING POSITION.

superseded by the disappearing turret (Figs. 5, 7, and 8), which is the only type now employed. In this turret the guns are retracted entirely within the armored portion. The portholes, which were very visible in the earlier turrets, are entirely covered, and they emerge from the concrete well only during the time required for firing.

The disappearing turret is constructed for one or two 6-inch guns, two 3-inch rapid fire guns or two machine guns. The type, however, does not vary essentially. The moving mass is counterbalanced by weights, as in the turret already described, but the improvements introduced into this system of counterbalancing by Galopin have made the turret for two guns the remarkably effective weapon which is now installed in our forts. The shafts of the counterweights move on steel rollers, so that the length of the lever arm varies during the motion in such a manner that the turret reaches its final position with zero velocity. The turret being in its position of eclipse, and offering only its low roof as a target to the enemy's fire, the guns are loaded, and are aimed by the indirect method, by means of drawn plans. Meanwhile the counterweight has been wound up, and when all is ready, at the word of command, a catch is released and the turret rises. At the top of its course, the two guns are discharged automatically by the closure of an electric circuit, and the turret immediately sinks. The time which elapses between the word of command and the complete disappearance of the turret is only five seconds, and two shots can be fired every 90 seconds.

The 3-inch gun turrets operate in a similar manner. The machine-gun turrets are somewhat different. As they are much lighter, they can be moved directly by the gunners, and so easily that they can be caused to sweep the whole crest of the glacis during the volley.

The thickness of the walls varies with the type of turret. For the large calibers it is about 12 inches, a thickness which offers an effective defense against

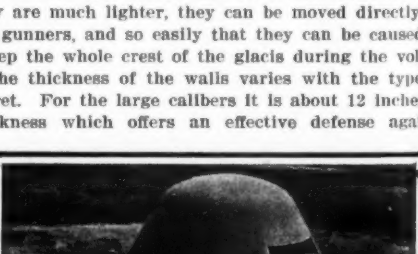


Fig. 6.—CONNING TOWER.

modern siege guns. In 1886 the Roumanian government, desirous of equipping its forts with armored turrets, made a very elaborate series of experiments with a French and a German turret. Neither turret was at all injured by either the explosive or the armor-piercing projectiles of that day. Since that time the precision of fire has greatly increased, but the force of projectiles has undergone less change, so that it is probable that these turrets would still withstand a siege without serious damage. Experiments are now being made with an 11-inch mortar, throwing a shell weighing 550 pounds. The nearly vertical fire of these mortars would certainly be very dangerous for the roofs of disappearing turrets, but it should be remembered that in the Roumanian experiments 164 shells were discharged from a German rifled mortar of 8 inches caliber, at a distance of less than 3,000 yards, without making a single hit. The French disappearing turrets are constructed in accordance with the results of experiments made in 1887, 1905, and 1906. In regard to their strength, they inspire perfect confi-

dence, and as their fire is very accurate, they constitute excellent weapons. Unfortunately, they are very costly, like all modern fortifications.—La Nature.

TO MAKE PLASTITE MASS.

THE mass so designated has a deep black color and sufficient hardness to admit of being sawed, planed, turned, and also highly polished. Owing to these properties of plastite, many articles, usually made of horn, metal, or hard stone, can be easily prepared from this material.

There are many recipes for compounding plastite mass. As a rule, in addition to the ingredients which go to make up the actual plastite, indifferent substances, most commonly magnesia, are used on account of their light weight as a filling. These serve only to increase the volume of the mass, and have no essential effect on their composition.

Plastite mass possessing in complete measure the excellent qualities mentioned above is compounded as follows:

Caoutchouc (India rubber).......	100	100
Sulphur	20	25
Magnesia	40	50
Golden sulphur of antimony.....	40	50
Coaltar pitch	50	60

These substances are mixed till they form a thoroughly uniform mass, which is first warmed to make it more plastic, then forced by means of vigorous pressure into iron forms and vulcanized in the ordinary manner like rubber. According to the intensity of the heat applied, the articles turned out are either elastic—almost as much so as rubber vulcanized in the usual way—or hard as ebony.

By using a highly plastic artificial asphalt, masses may be prepared in this manner differing very little in regard to elasticity from vulcanized rubber, though containing comparatively little of the latter substance.

Such masses, displaying approximately the properties of genuine whalebone with respect to their elasticity, are also described as artificial whalebone or balenite. Made into thin sticks, they are used in the same way as genuine whalebone.

THE WONDERS OF FORMER AND PRESENT PHYSICAL MEASUREMENT.

THE degree of exactness attained by scientific methods of measurement and weighing is known to comparatively few persons and must provoke boundless amazement in the general reader. A recent number of Die Deutsche Revue publishes a digest of a lecture delivered in Amsterdam by Prof. Woldemar Voight of Goettingen on the stupendous progress made in the methods of physical measurement. The title of the lecture was "The Struggle for the Decimal in Physics." Says the Revue: "What degree of exactness is attainable in physical measurement? That is the question. At the present day a thoroughly skillful cabinet-maker can put out work of which the dimensions are true to a per cent. that evokes enthusiastic praise. To physicists such a degree of exactness signifies really nothing, and they are constantly striving to attain a further decimal for all constants. Voigt selects as an example the determination of the degree of the force of gravity, or, what amounts to the same thing, the determination of the length of a pendulum for seconds. In his experiments with gravitation at the leaning tower of Pisa, Galileo observed that the duration of the fall of an object dropped from the top of the tower was three and a half seconds. In this the initial and the final moment of the fall can be determined to the fifth of a second approximately, that is, the exactness of the statement of time may depend on an eighth.

"For the solution of this problem the Dutchman Huyghens used a pendulum that at once brought exactness to a thousandth, not because the initial and the final moment of the oscillation of the pendulum was determined, but because the number of oscillations was measured. So it was believed that correct figures were now determinable. Then the remarkable discovery was made that the length of the pendulum was not equal under different latitudes, and so a source of error in measurement was found. Soon another was found; as a method of determination there was hung before a clock a thread pendulum that was regulated until it struck the second; in this the investigator had to keep in view that one pendulum influences the other and thus exactness could again be enlarged; as a result of the investigation conducted by the Paris Academy in 1730 in this direction the astronomer, Mairan, discovered a new source of error, the stiffness of the thread of the pendulum, while he kept in view that the pendulum used was not a mathematical, but a compound one. Certain theoretical considerations thus evoked again improved the statements. Borda, too, found many sources of error, all of which were taken into account, * * * for instance, the influence of temperature, the extension of the thread of the pendulum through centrifugal force during the oscillation, and the swelling of the pendulum in consequence of the surrounding air. Still more important progress was made by Bessel, whose calculations regarded also the quantity of air carried along by the ball of the pendulum. He determined finally for the length of the pendulum for seconds, under a given latitude, a value of which the exactness was calculated to one-five hundred thousandth.

"Many a one who is the possessor of a letter-scale firmly believes that this instrument is a model of exactness. But chemistry works with scales that indicate with certainty the fiftieth part of a milligramme. A chronometer is a beautiful thing, indeed, and the owner of it has the manifest right to be proud of this little masterpiece of technic. But what can its accuracy to a second signify as an indicator for the sharp observation of a Foucault, the famous natural philosopher, who has measured the time that light takes to go a distance of twenty meters and has determined it as the sixteen millionth part of a second? For measurement of the length of the waves of light use is made of the so-called 'trellises,' and that is, strips of silver, every millimeter of the length of which is marked with one thousand lines and can, therefore, indicate the millionth part of a millimeter. A pendulum constructed for the measurement of angles has indicated a movement of the three hundredth part of an angle second. To grasp approximately the smallness of such an angle one needs only to imagine rays proceeding from his eyes and striking, at a distance of sixteen hundred kilometers, the edges of a thin disc having a diameter of one inch, say. Spectrum analysis, for instance, can indicate marvelously small quantities, say even the three millionth part of a milligram of natron, which, when such a small fraction is burned, still betrays itself through a distinct yellow line in the spectrum."

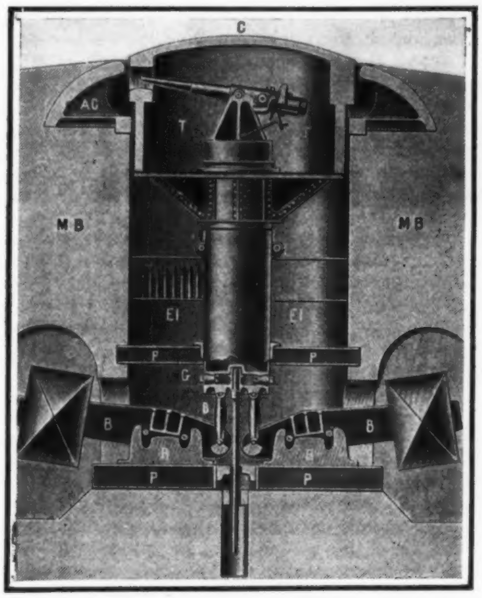


FIG. 7.—SECTION OF GALOPIN DISAPPEARING TURRET.

C, armored roof and hood; AC, armored rim; T, firing chamber; MB, concrete; EI, operating room; B, arms of counterweights; R, rollers; P, iron beams.

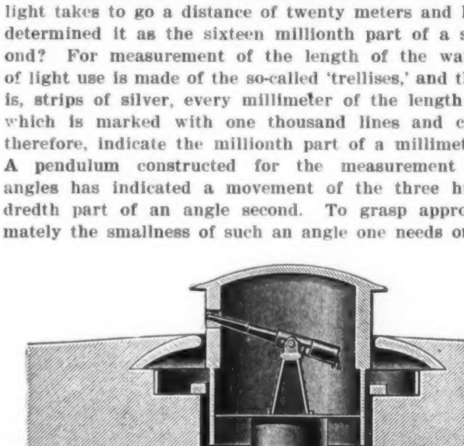


FIG. 8.—SECTION OF 3-INCH DISAPPEARING TURRET IN FIRING POSITION.

PROTOPLASM IN HARNESS.

GALLS on plants, in at least the more conspicuous forms, must have been known to man from a very early period in his history, and the presence in them of living animals might have been expected to suggest inquiries as to their source and relation to plants, yet even after Malpighi had published the results of his study of various galls, and had been followed by Reaumur in his admirable "Mémoires," the interest in those curious growths long remained limited to a very few. To botanists they were little more than excrescences on, or defects of, plants, lessening their value as specimens, while zoologists were rarely attracted to the study of the makers, which belonged for the most part to mites, nematode worms, midges, and other groups difficult to study, and little attractive in themselves.

But the latter half of the nineteenth century was marked by an almost sudden outburst of activity, about 1870, led by Drs. F. Thomas, D. von Schlechtendal, F. Löw, G. Mayr, and others, resulting in numerous papers filled with descriptions of previously unknown galls, and gall-makers, and with life histories disclosing new relations between plants and animals, as well as new cycles of development of the animals. Such discoveries as the surprising dimorphism so general among the Cynipidæ that gall the oaks attracted keen interest, which showed itself in an increase of workers, and in a more and more rapid advance in the study of galls, especially in faunistic researches, and in more accurate determinations of the gall makers and the influence on one another of the host and the parasite.

The diversities in structure among galls (the alterations induced by the gall producers in some cases amounting only to slight enlargement of the parts involved, while in others they result in bodies of complex nature and definite specific forms), and the sysmatic relations among the numerous gall-bearing plants, and also among the gall-producers, support the belief that the power to affect the protoplasm so as to lead it to produce structures useful to the gall makers has been acquired independently by numerous organisms (plants as well as animals), in widely different grades of development. If that is so, it seems reasonable to expect that power to control the activity of protoplasm will, at least to some extent, be acquired by man, and may produce results of great value. Although as yet experiments have thrown little light on the artificial production of galls, there is a very attractive field open for research in this direction.

Since 1870 an extensive literature has appeared dealing with galls, dispersed so widely that much of it was almost beyond reach of even keen students in this field. In 1858 G. von Haimhoffen estimated the known galls of Europe at from 300 to 350. In Kaltenbach's "Planzenfeinde," issued in 1873 and 1874, the galls of central Europe formed by insects, and by a few mites, were described under the host plants; and from 1890 to 1895 D. von Schlechtendal issued a catalogue of the galls of animal origin then known to occur in Germany.

In 1901 appeared two works giving brief descriptions of the galls of Europe and of the Mediterranean area, Kieffer's "Synopsis des Zoocécidies d'Europe," and Darboux and Houard's "Catalogue systématique des Zoocécidies de l'Europe et du Bassin Méditerranéen." These were most welcome, and stimulated research so greatly that a new catalogue had already become necessary when M. Houard supplied the need by his latest work, "Les Zoocécidies des Plantes d'Europe et du Bassin de la Méditerranée." Based upon the "Catalogue," and covering the same area, comparison of the two shows remarkable progress during the few years that elapsed between their dates of issue. Such a comparison is a little hindered by the host plants being arranged in the earlier list in alphabetical order of the generic and specific names, while in the later they are in families, these following the order in Engler's "Pflanzenfamilien," while within each family the genera and species are grouped after Nyman's "Conspectus Floræ Europeæ." The advantages derived from the rearrangement of the host plants beside their allies far outweigh those of the alphabetical arrangement.

The comparison between the individual hosts in the two lists shows very careful revision of the descriptions common to both, the omission from the second of some forms included in the first, the definite reference to their makers of numerous galls previously of unknown or doubtful origin, and the addition of many recently discovered galls, some on plants already known to bear galls, others on new hosts. A rough indication of the advance is given in the rise of the marginal numbers attached to the galls from 4,169 to 6,239; but perhaps a truer value is afforded by the increase of the host plants in much the same proportion, and of the known gall makers from 1,072 to 1,366 species, the increase being especially large among the Curculionidæ (beetles), the Cynipidæ (gall flies), the Cecidomyidæ (gall midges), and Eriophyidæ (gall mites).—Nature.

TECHNOLOGICAL CHEMISTRY.

ITS DEVELOPMENT DURING THE LAST FORTY YEARS.

BY PROF. O. N. WITT.

THE representatives of chemistry, general and physical, inorganic and organic, have striven in noble emulation to surpass each other in the number and importance of their discoveries. From the laboratories great and small, official and private, the results of research have flowed like the rivulets which, irrigating the well-watered fields, come together in brooks, then in streams and in rivers, bringing fertility to the habitations of men in the valleys. An abundant harvest has been raised on these watered plains, a harvest which has been enthusiastically consumed by the people.

The harvest, the reward of scientific research, the abundant fruit of the patient work of the mind, consists of the applications which contribute to the well-being of the people. This is why technical chemistry is the worthy companion of abstract research in our science. It should prosper when research is flourishing, and the additions to chemical technique, during the last forty years, are a striking proof of the correctness of this assertion.

About the time when the German Chemical Society was founded a period of far-reaching transformation began in industrial chemistry. The industry of mineral acids and alkalis, based on the Leblanc process—the only one which could boast at that time of the title "great chemical industry"—still adhered to its stereotyped operations and to the dependency of its series of steps, one upon the other, but the young Titan which was destined to struggle with and cause its complete rehabilitation—the Solvay process for the production of soda by means of ammonia—had come into existence and was already developing. About 1870 this process appeared to have reached a productive stage, and it was recognized that the possibility of obtaining soda independently of the Leblanc process would break up the whole continuity of this great chemical industry. It was still protected, however, by the close dependence on it of the production of hydrochloric acid and from this the making of chlorine by the sulphate process, and by the advantages offered by the soluble product of its raw soda in the preparation of caustic soda. In truth, these two circumstances prolonged the life of the Leblanc process for several decades and are responsible for the fact that even yet it has not entirely disappeared.

Toward 1860, almost simultaneously with the development of a commercial process for the production of soda by ammonia, came the inauguration of the potash industry at Stassfurt, which was founded on the fortunate discovery of the deposits of salts there, under the fertile influence of Liebig's wonderful researches.

To the preparation of potassium chloride from carnallite and sylvinite soon were added the preparation of bromine, of potassium nitrate by the use of sodium nitrate, and the manufacture of potash by the Leblanc process, without any danger here of a concurrent process with ammonia. Finally, a successful process was developed for the utilization of part at least of the magnesium compounds which were present in the salt deposits, although the successful extraction of all the magnesium chloride made in the potassium industry is to-day still in the category of unsolved problems.

The year 1870 saw the rejuvenation of the century-old industry of oil of vitriol, the fuming sulphuric acid, whose small content of sulphuric anhydride no longer sufficed for modern needs.

In place of the product obtained by distilling vitriolic schists came synthetic sulphuric anhydride, prepared by the catalytic combination of sulphurous anhydride and oxygen, and the pyrosulphuric acids. The new process of manufacture was to influence and transform the whole sulphuric acid industry to a great extent. It was possible to apply it with advantage more than a quarter of a century later, when the modern process appeared.

The last two decades of the nineteenth century were characterized by the development and application with exceptional rapidity of electro-technics. In the field of chemistry, this new phase of industry voiced itself in the development of electrolytic methods of operation. In the field of electro-metallurgical processes, the most important of which are the preparation of aluminium and the electrolytic refining of copper, which are closely followed by the manufacture of calcium carbide and carborundum, the question of the electrolytic decomposition of alkaline chlorides has been a most warmly discussed problem. The difficult problem of preparing membranes which are more sensitive, and at the same time more resistant, was solved almost simultaneously by three processes, that of Griesheim, that of Castner-Keller, and that of Aussig, which are close rivals in their effectiveness and boldness of invention. With these a new era has begun in the production of caustic alkalis, and also in the chlorine industry. The old process for the production of chlorine has disappeared along with the ingenious methods of Weldon and Deacon. Chlorine, once so costly, is produced in such abundance as to provoke a feverish search for new applications for it. By the side of and often in the place of the venerable chloride of lime we find to-day liquefied molecular chlorine put up in transportable form in steel bottles.

Finally, the production of alkali metals on a large scale should be counted as one of the most important results of modern electro-chemical technology. The same reaction in a form suitable to technical methods which once in Davy's hands led to the discovery of these metals—the electrolysis of alkaline hydrates—has shown itself to be the best and least costly method of manufacture for these strongly reactive bodies, one of which especially, sodium, has rapidly become of extensive application in a technical way. By its aid in particular, it has been possible to produce potassium cyanide free from cyanates, which has contributed to the success of the cyanide process for refractory gold ores.

Such a metamorphosis of inorganic chemical technology as has been briefly described would not have been conceivable if greater and greater quantities with their continually decreasing prices had not found a continually increasing market. The same fact along with the natural increase of needs generally has produced in the case of organic chemistry an even more striking and remarkable transformation and development than in inorganic technical processes.

We all know in a general way that the old industries of brewing, distilling, sugar making, and starch making, of the production of fatty bodies and of foods, all of which are connected with agricultural work, have flourished remarkably in the last forty years and have become of very great importance. They owe their most important progress to the aid of modern biological research. But besides these, other industries operating on organic substances have sprung up and prospered, which were formerly entirely unknown.

A lively interest attaches to the chemical application of wood which has not only allowed a particularly profitable use of our forests, which is coming more and more into evidence, but has also led to a simple separation, almost analytical in its nature and carried out on a large scale, of the components of lignine, one of which, however, the incrusting medium, remains to this day a chemical enigma.

The extraction of an almost pure cellulose from wood has placed the paper industry on a new footing and has obviated the necessity of our limiting the production of printed matter for want of paper. It has led to the discovery of a number of other useful applications of cellulose, of which I will mention only the preparation by various methods of new artificial textile fibers analogous to silk.

Wood can be worked chemically, however, in another way than by the separation of its content of cellulose. I refer to the process of dry distillation. The very primitive preparation of carbon and wood tar of the old days has developed during the last forty years into a very highly perfected art of wood distillation, which has obtained most important commercial results with decomposition products formerly entirely neglected—methyl alcohol, acetone, and acetic acid. The attempts, first without result, but later crowned with success, to free the ligneous acetic acid from the empyreumatic bodies obtained with it have resulted in the fact that the greater parts of our demands for acetic acid are now supplied by the distillation of wood. This industry received a still further impetus in 1890 by the introduction of a process for the preparation from methyl alcohol of formaldehyde, the production of which has enormously extended since the extraordinary variety of uses to which this new product can be put has been recognized.

Another remarkable method for the treatment of wood, fusing it with alkali for the production of oxalic acid, has not developed, but rather has diminished in importance during the forty years under consideration. It has been replaced by the synthetic method of preparing this acid, as well as of formic acid, by means of carbon monoxide contained in generator gases. Formic acid can be prepared so advantageously in this way that it is competing with acetic acid in many of its applications.

The commercial utilization of hydrocarbons of the methane series is brought out in two industries—the distillation of lignites and the refining of petroleum. Both of these industries have shown an extraordinary increase in their extent and have displayed numerous marked improvements in their production. Among the latter the desulphurization of fetid petroleum of the Ohio type by distillation over copper oxide should be considered a technical achievement of high rank.

The development of coal distillation and the treatment of tar affords a particularly important and interesting example of progress. When this society was founded only one form of distillation of coal was recognized—its application to the manufacture of illuminating gas, which dates from the end of the eighteenth century. This distillation was carried on at a low temperature and furnished the entire amount of tar produced, the tar which is so important in the recently developed color industry. In 1880 the output of tar began to be less abundant, a fact caused not only by the constant increase in its use in the production of tar dyes, but also to a great extent by the far-reaching transformation of the gas industry, which on account of extended and ingeniously interpreted experiments had been developed into an entirely new process, characterized by the employment of high temperatures of distillation. The momentary embarrassment which fell on the dye industry led to the creation, far-reaching in its consequences, of a new industry—distillation for coke, which saves from destruction the riches contained in the by-products of coke manufacture and which frees for a long time the dye industry from any lack of raw materials.

Among the products derived from coal tar may be mentioned anthracene, carbazol, the xylenes and the cresols, coumarone and pyridine, substances whose systematic manufacture is only forty years old and which have found a steady commercial application. Of many of the other of the tar derivatives, some have been only recently discovered, while others have been rendered more available than heretofore.

It is to the improvement in its methods of operation, especially in the apparatus, that the industry of tar distillation owes the thoroughness with which its products may be separated from such a complex mixture as goes to make up tar. Column stills, filter presses, and processes such as vacuum distillation are the means which have enabled the modern tar industry to attain its present position.

The most striking example of an industry working hand in hand with scientific research, profitably applying all its results and influencing them in its turn, is afforded by the manufacture of coal-tar colors. It is almost impossible to touch in these few words on the most important stages of the triumphal progress of this industry.

We may say that the foundation of the German Chemical Society was coincident with the date when the newly founded color industry was emancipated from empirical methods and turned toward scientific synthesis. The first great success obtained through this agency was the creation of the alizarin industry, whose later development has surpassed all expectations. The recognition of the close connection between constitution and properties of coloring matters found its practical application in the introduction of azo dyes, which not only brought into the industry an extraordinary variety of colors, but accustomed the dye chemist to develop almost quantitative methods of work. In the group of phthaleins were found not only some of the most striking coloring materials, but also some of the most permanent, thus refuting the theory, not proved, but then current, that artificial colors were ephemeral in the same proportion that they were brilliant. Equally permanent dyes were found among the eurhodines, safranines, oxazines, indulines, and thionines, the study of which is so intimately bound up in that of nitrogen chains and the joining of nuclei. The discovery by a mere chance of a fast alizarin blue, so important from a technical point of view, likewise carried in its wake great consequences for scientific chemistry, for the investigation of the composition of this dye led to a synthesis, capable of general application, of the derivatives of quinoline. In a like manner the explanation of the constitution of rosaniline was very productive in allowing the synthesis of numerous

* Address before the German Chemical Society at the celebration of the fortieth anniversary of the society, November 11th, 1907. Translated in Smithsonian Institution's annual report from Berichten der deutschen chemischen Gesellschaft, Jahrgang XXXX., Heft 17.

new compounds, among which are found some of the most beautiful and valuable dyeing materials.

The appearance of substantive azo colors, and finally of those known as "sulphonated dyes," has not occasioned the opening of any new avenues of scientific investigation. These two accomplishments, however, are of the greatest importance in that they have provided new methods for dyeing and printing and have completely revolutionized these two ancient industries.

Lastly, we may mention the new class of indanthrene colors in which are united clear tints with an hitherto unknown resistance to all destructive influences.

It is the synthesis of indigo, however, that we must hail as the most brilliant of all conquests in the field of coloring materials. We can still recall the day when the great event in chemical history was made public and when every hand was extended in congratulation for this masterpiece of scientific research. The struggle for a solution of this great problem cost twenty years of assiduous labor, but, once solved, how well the new product of synthetic indigo has stood the test beside the natural product backed by several thousand years' use.

There is no hope that this industrial triumph in the coloring field will ever be surpassed. It is none the less certain, however, that this industry has not yet attained the limit of its development. Our reviews in the future will still record many achievements bearing witness to the uninterrupted development of this interesting and manifold branch of technology.

We may consider the manufacture of synthetic medical preparations as an offshoot of the color industry which sprang up in the period we are considering and which has already earned a position of its own. What brilliant results have been accomplished in this field, also. What a beautiful gradation of development from complex insufficiency to simple perfection can be witnessed in comparing kairine and thalline on one side and antipyrine, phenacetine, and aspirine on the other. What a progress in the regulation of physiological functions is evidenced in chloral hydrate and verronal. What pains has not synthetic chemistry soothed by its activity in this field, what ills has not it assuaged.

The industry of artificial medicines is only one of a vast circle of varied activities which we are in the habit of grouping together under the collective term of preparation industries. To properly appreciate this industry with all its ramifications is impossible. Nevertheless I cannot help mentioning the appreciable growth of a branch of this industry which is almost as old as this society. This is the manufacture of chemical products and preparations for photography, whose expansion has been closely connected with the development of scientific photochemistry and with the introduction and popularization of dry photographic plates with their proper processes of development.

No less interesting are the chemical and technical aspects of the perfumes newly created and developed during the last forty years. This field, which is completely developed along its principal lines at the present day, was still unexplored at the time when the German Chemical Society was founded. Its expansion is reflected more completely in the pages of our transactions than anywhere else. Step by step nature has been imitated in its creations, and in this field perhaps more than anywhere else the synthetic chemist has taken paths which follow those of nature.

Among the synthetic industries we should count the technology of explosives, although here it is a matter less of constructing molecules than of storing up energy in a form easily liberated. In this industry great progress has been recorded, almost all of which depends on the utilization of the facts expressed by the law of Sprengel, expounded about forty years ago, and on the employment more and more of safe explosives which can be detonated only by an initial ignition, in place of bodies themselves explosive. The possession of such explosives and the application to the phenomena of explosion of modern methods of observation have alone made possible the new orientation in ballistics, which is well known to all of us.

If we consider all this technological progress that I have mentioned and much more which I must refrain from describing, we must agree that as far as applications are considered our science has reached a hig[h] state of development. But just as scientific researc[h] in spite of the abundance of results, still presses fo[r]ward, so will technology not stand still, but will co[n]tinue to attack more and more difficult problems.

When this society was founded there was alread[y] it is true, a very well-developed series of chemical i[n]dustries, but their activities were limited almost e[n]tirely to the extraction, purification, and transform[a]tion of natural products. An industry operating sy[n]thetically on a large scale is a development solely ‹ the last forty years. To-day we are striving for eve[r] more lofty ends. We have dared to lay a hardy han[d] even on the great processes of nature in seeking t[o] influence them according to our needs. It is this th[at] we behold in the great factories where many a[re] striving to utilize the nitrogen of the air. Man[y] methods have been proposed to attain this end; t[he] combustion of nitrogen to its oxides and the transfo[r]mation of it into cyanogen or ammoniacal compoun[ds] have been used.

All these methods are practicable and will a[ll] probably be productive of results. Which ‹ these results will be the most important it is f[or] the future to decide. In all of them, however, is th[e] characteristic feature—they do not rob Nature of [her] amassed treasures, nor do they wish to imitate h[er] creations; they aim merely to assist her in one of h[er] greatest processes, the circulation of nitrogen. If w[e] succeed in influencing this phenomenon, we will al[so] in a measure control that other which is so intimate[ly] bound up with our fortune or misfortune, the cour[se] of life. We will force the earth to greater fertility, [to] an increasing habitability.

In such a task Nature herself should be our all[y]. The savage force of the water which falls from abo[ve] carries out the chemical work which we call upon [it] to perform, and a day is beginning to dawn when [it] will be not only a pretty metaphor, but one of peculi[ar] force and meaning, to speak of the fertile influence ‹ the brooks which ripple down from the mountains in[to] the valleys where stand the habitations of men.

LIQUID AIR AND OXYGEN

SOME NEW USES.

Some interesting industrial applications of liquid air and of oxygen made from liquid air were noticed in a recent paper read by Mr. George Claude before the Society of Civil Engineers of France.

Commercial plants for the production of liquid air by the Claude process or by the Linde process exist in various European countries (there is also quite a large one in this country using the Linde process, in Buffalo, N. Y.) Their chief product is compressed oxygen, and the principal applications of the oxygen are autogenous welding with the oxy-acetylene flame, cutting of metals with the oxy-oxy-acetylene flame, and the manufacture of artificial precious stones.

But the price of oxygen thus produced is still comparatively high, as Mr. Claude points out, on account of the large expense for compressing and bottling the oxygen gas in cylinders and the shipping expenses. The cost of the oxygen gas would be greatly reduced if it were required in large quantities on the spot. An essential item in the cost is represented by the pressure to which the air under treatment must be compressed. This pressure is given by Claude as 18 atmospheres for apparatus producing 100 cubic meters (3,530 cubic feet) of oxygen per hour, and is estimated as 10 atmospheres for 1,000 cubic meters (35,300 cubic feet).

At present 1 cubic meter (35.3 cubic feet) of oxygen is obtained per horse-power-hour in apparatus producing 50 cubic meters (1,765 cubic feet) per hour. The figure of 1.25 cubic meters (44 cubic feet) of oxygen per horse-power-hour is guaranteed by the Société de l'Air Liquide for apparatus producing 200 cubic meters (7,060 cubic feet) per hour; and the figure of 1.75 cubic meters (62 cubic feet) of oxygen per horse-power-hour represents the hopes of the manufacturers for apparatus producing 1,000 cubic meters (35,300 cubic feet) per hour.

A plant for the yearly production of 50,000,000 cubic meters (1,765,700,000 cubic feet) of pure oxygen requires not more than 20 meters by 30 meters (65 feet by 98 feet) floor space and 15 attendants.

For a plant to be erected with apparatus producing 200 cubic meters (7,060 cubic feet) of oxygen per hour, Mr. Claude's company has guaranteed that the cost of producing 1 cubic meter (35.3 cubic feet) of oxygen, including amortization, will be slightly more than 0.6 cent; that is, figured on the basis of the cost of 0.4 cent per horse-power-hour (an exceedingly low price which is thought to be justified because blast-furnace gases are used in driving the gas engines for power production at that place).

A very important and interesting experiment on a large scale is soon to be made by a Belgian iron and steel plant, the Société d'Ougrée Marihaye, with respect to the enrichment of the air with oxygen for the blast in one of their blast furnaces and converters.

At the conclusion of his lecture Mr. Claude showed a number of experiments, like the liquefaction of oxygen in contact with liquid nitrogen; the condensation of atmospheric air on the outside of an iron bottle containing liquid nitrogen; further, the fact that coke maintained at the temperature of liquid air absorbs gases with such energy that it is possible to realize rapidly a vacuum of less than one-ten-thousandth of a millimeter. Mr. Claude also subjected a current of illuminating gas fed to a burner to the action of liquid air; the result was a modification of the flame which assumed the characteristic appearance of the hydrogen flame. This experiment indicates the possibility of a cheap process for making hydrogen by partial liquefaction of water gas. Other experiments illustrated the ease of recovery of volatile substances in chemical industries by refrigeration, such as ether and alcohol in the manufacture of artificial silk, and the facility of extracting neon and helium from the atmosphere.

In this connection it is interesting to report a lecture delivered November 18th, 1909, before the Polytechnic Association of Berlin, by Dr. H. Erdmann on the technical application of liquid oxygen. (Chemiker Zeitung.)

Dr. Erdmann first discussed briefly the chemical properties of the liquid gas and also described a modified arrangement for investigation of its purity by means of the aerometer. It is possible to utilize liquid oxygen at the same time for three purposes, namely, to utilize its cooling effect, the pressure, and its chemical energy.

The consumption of liquid oxygen is much greater than is generally supposed, although we have no accurate statistics regarding it. Three methods of manufacture are in use. By the Brin method, barium oxide (BaO) is heated in a current of atmospheric air to form barium peroxide (BaO_2). The air current is then stopped, and the barium peroxide reheated in a partial vacuum, whereby oxygen is given off. By the second, the electrolytic method, the gas is obtained from water, but this is economical only when there is use at the same time for the hydrogen generated simultaneously with the oxygen in equivalent proportion. Electrolytic cells for this purpose have been devised by Schuckert, Garuti, Schmidt, and others. The third method, based on the fractional distillation of liqui[d] air, is now very largely employed in Europe. Fo[r] operation on a large scale the cascade principle, whic[h] was first used by Pictet in 1877, is used to advantag[e]. The lecturer mentioned briefly the processes of Cai[l]letet, Kamerlingh-Onnes, Claude, Hildebrand, an[d] Linde.

Altogether there is annually produced in German[y] 8,000 cubic meters (282,500 cubic feet) of oxyge[n] (meaning evidently oxygen gas at atmospheric pre[s]sure) by the Brin method, 342,000 cubic meters (12,070,000 cubic feet) by the electrolytic method, an[d] 2,200,000 cubic meters (77,700,000 cubic feet) by th[e] fractional distillation of liquid air. The average co[st] for one kilogramme of fluid oxygen amounts to abou[t] 10 pfennigs.

The oldest use found for oxygen is in explosive[s] oxygen cartridges not being dangerous. In recen[t] years oxygen has found use in the production of ligh[t]. In this connection was mentioned the Nürnberg ligh[t] which it has been found consumes very little illum[i]nating gas and produces less heat than the ordinar[y] gas lamp. It is also more hygienic since the oxyge[n] is supplied to the flame and is not, therefore, take[n] from the air, thus contaminating the latter. In meta[l]lurgy oxygen finds many uses; for instance, in th[e] oxy-hydrogen and oxy-acetylene flame for autogenou[s] welding and cutting of metals. Oxygen is also used f[or] the production of fused quartz (silica) vessels. Oxy[gen] used in medicine must have the highest purity[;] this accounts for the higher price. According to Mi[]chaelis, oxygen, which is 96 to 97 per cent pure, cost[s] 6 marks ($1.43) per cubic meter, while 99 per cen[t] oxygen costs 10 marks ($2.38).—Metallurgical an[d] Chemical Engineering.

The Baku papers state that the exploitation of th[e] well water—i. e., the water that accompanies th[e] naphtha in the bore holes, which consists of a con[]centrated salt brine—is about to be commenced. I[t] contains iodine and bromine, both of which can b[e] extracted and the remaining liquor evaporated fo[r] salt. Attention is also called to the water in th[e] Grosny wells, particularly in the Daghestan distric[t] where, during the boring, highly concentrated brin[e] was found—with the naphtha—rich in iodine. Th[e] idea of treating these waters is not of course new[.] Mr. K. I. Liseko long ago called attention to the ric[h] content of salt and iodine they held, and which wer[e] run into the sea from the Baku wells. But for wan[t] of means they had to be let go on.

HE URANIA-ZÜRICH EQUATORIAL TELESCOPE.

AN ELECTRICALLY CONTROLLED INSTRUMENT.

BY FRANK C. PERKINS.

MOST interesting equatorial telescope is in opera- at the Urania-Zurich Observatory in Switzerland, escope which is of unusual interest because it is rically controlled. It is seen in our illustration ted for tests on a brick foundation.

e intricate eyepiece and controlling wheel of this equatorial telescope and the construction of the ic automatic weight elevator and the astatic fric- spring governor with the electric second control ed on this instrument are also illustrated.

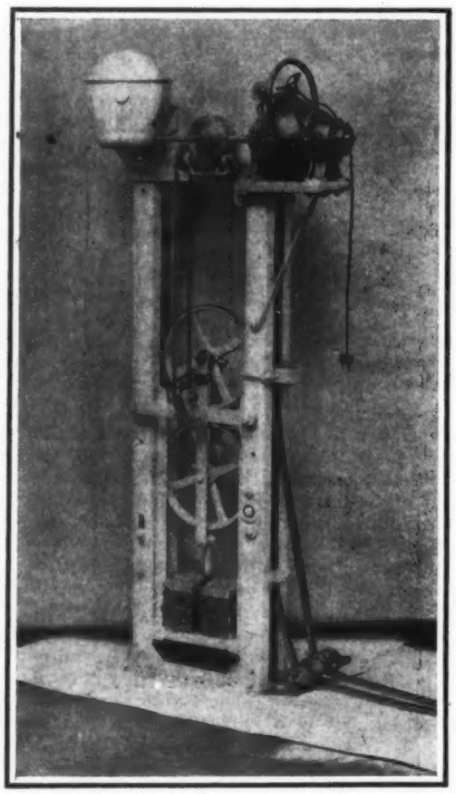
ere is not only an electrically operated equatorial se system for the hour circle, but also for declin- . It may be stated that the introduction of graphy as an indispensable auxiliary to the re- or and its simultaneous employment for visual vations of different kinds as well as for differ- l measurements, and the spectroscopic observa- make it necessary to construct instruments with greater light gathering power than heretofore, s a consequence larger dimensions are necessary,

placement due to them. When these displacements attain a certain position the automatic commutator sets the electric motor in action or cuts it out. When the observations are ready to begin the motor is placed in circuit by means of a switch and the winding mechanism is connected with the governor by means of the transmitting shaft.

It may be mentioned that the friction spring governor is astatic, that is to say, once the velocity of revolution is adjusted it remains constant by the amplitude of the balls, the centrifugal force being proportional to the distance of the balls from the axis of rotation. This force is always balanced by the tension of a spring, suitably connected with the governor arms, and by modifying this tension the angular velocity can be regulated between certain limits, the governor regulates the mechanism by means of centrifugal force accompanied by the increased amplitude of the balls.

An electric-second control is provided in addition

EQUIPMENT FOR WINDING UP THE WEIGHT.



THE ELECTRIC SECOND CONTROL.

THE URANIA-ZÜRICH EQUATORIAL TELESCOPE.

osing special conditions on the construction of the cope mountings.

e telescope mounting must have its movable parts led into two equatorial systems for holding the ument upon the object observed. There must be plete avoidance of all flexion of the hour and ination axis, with ease of movability about the r, entirely relieving it from strain, by means of a ial supporting system. There must be such a nting of the telescope that relative changes of e of the ocular end of the instrument are reduced minimum and the mounted auxiliary apparatus, as astrophotographic cameras, must be within reach of the observer at the ocular end.

may be stated that the Urania-Zurich instrument an aperture opening of 300 millimeters (12 inches) a focal length of 5 meters (16.4 feet). The tele- e is driven by clockwork and needs no super- n during observation.

e of the accompanying illustrations shows the pment for automatically winding up the weight driving the clock train by electric power. An- r illustration shows the friction spring governor electric second control for regulating the drive.

he electric automatic weight elevator is of inter- g construction. The weight is suspended by a e endless chain and is continuously wound up by electro-motor. A resistance regulates the irregu- ties in the speed of the motor and the vertical dis-

to the governor, consisting of a friction coupling and an electro-magnetic circuit breaker. The control is brought into action by a pendulum beating the seconds by means of a conducting wire. When an ordinary electric light current is used from a central station, it is necessary to insert a resistance such as an incandescent lamp into the circuit as indicated.

It will be noted that the connecting rod transmits the governor motion to the driving of the hour wheel, there being two driving worm wheels engaging the hour wheel at two diametrically opposite points. These are coupled together by a shaft in such a manner that each of the two worm wheels transmits an equal force to the hour wheel. In consequence, the hour axis is not loaded by the turning forces, and errors of driving in the hour wheel, if such exist, do not affect the hour motion of the instrument by more than a fraction of their value.

It is of interest to note that the slow motion of the telescope is operated in both co-ordinates by means of rods from the ocular end. These rods are provided with toothed-wheel gearing, permitting the speed of the two motions to be rapidly changed from ocular end.

In accordance with the factory and workshop act of Great Britain, the British government has issued regulations relating to safety arrangements to be used in dry grinding and finishing processes. According to these rules all grinding wheels must be provided with a hood or other appliance so constructed and arranged as to take care of practically all dust created. A duct of adequate size arranged to carry away the dust must be provided, and a fan or other effective means for extracting the dust must be installed. Suitable respirators must also be provided for all persons employed in grinding, whether working in a room or in the open air. No person is permitted to do any work other than grinding in a room where grinding is carried on, except work required for cleaning purposes. Provisions are also made for effective cleaning of rooms in which grinding is carried on, at least once a week. The employer is required to furnish all safety apparatus, respirators, etc., and every person employed is required to make full and proper use of the appliances provided.—Machinery.

SCIENTIFIC ACCELERATION AND BRAKING.

DR. H. S. HELE-SHAW, president of the Incorporated Institution of Automobile Engineers, took the chair at the fourth meeting of the session of that body in the Institute of Mechanical Engineers, Westminster, when Mr. F. W. Lanchester lectured on "Tractive Effort and Acceleration of Automobile Vehicles on Land, Air, and Water." He dealt with some of the more generally neglected aspects of the subject, and endeavored to demonstrate the method employed by him for the measurement and recording of acceleration and tractive effort. He argued for the expression of all quantities under one kind of unit as against the rather general method whereby the tractive effort and resistance are commonly given in terms of pounds per ton of gross load, and quite frequently they are measured positive in opposite sense. Thus the tractive effort is reckoned positive under the direction of motion, and the resistance is positive in the reverse direction. To-day, by the use of a pendulum accelerometer, an improved type of which was designed by Mr. Lanchester in 1904, it is possible to take the most accurate readings. He showed diagrams of readings taken with this pendulum instrument concerning brake tests taken on various parts of the Great Western Railway system and on the Piccadilly Tube.

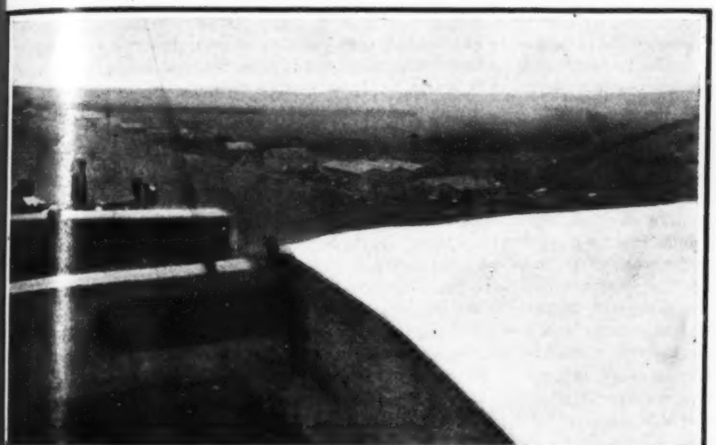
IDEAL AND ACTUAL METHODS CONTRASTED.

It is now well understood that the correct manner to brake a train or any other kind of vehicle, if the comfort of the passengers is to be considered, is to withdraw the brakes somewhat as the vehicle comes to rest, the ideal condition being that at the instant of coming to rest the brake effort should be zero. Of course, in practice the most that could be done was very materially to diminish the extent of the brake effort, though, in fact, it was comparatively rarely that even that was done, because it was so easy for a driver to stop at a given place by reducing the speed to about five or ten miles an hour, then virtually to "clamp" the vehicle at the desired spot by the full application of the brake. On the other hand, it required very great judgment and skill, as well as perfect mechanism, to stop at an exact place with a "tailing-off" brake diagram. In the case of railways, the lecturer thought it was a question whether any great improvement would be made in this direction unless some automatic mechanism were adopted and actuated from the track itself. He pointed out that in regard to railway trains the rate of change of acceleration should be limited, and that the acceleration curves should be of smooth contour, never exceeding some specified gradient. Then there need be no artificial limit set on the maximum acceleration. Since a sudden change of acceleration resulted in the passengers' loss of equilibrium, if such sudden change took place, it depended on what the actual acceleration was immediately afterward. He said that in vehicles such as urban electric tram cars a magnetic brake was frequently fitted. When it was used the acceleration was not limited by the ordinary considerations. The slipping limit no longer existed, for the friction was not dependent on the weight of the vehicle, but on the magnetic suction, which might be made as great as they pleased. If too powerful a magnetic brake were employed to the full, it might be just as dangerous to the life of the passengers as an actual collision. Passengers had been thrown from one end of a tram car to the other, and others had been unseated, by the injudicious using of such a brake. In that case we probably had both the sudden change of acceleration and an excessive maximum immediately succeeding. The first threw the passenger down, and the second prevented the least chance of his recovery.

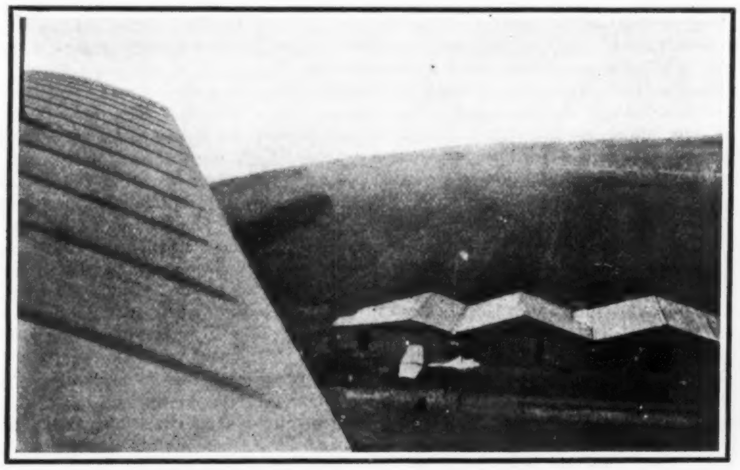
PHOTOGRAPHING FROM AN AEROPLANE.

PICTURES TAKEN FROM LATHAM'S "ANTOINETTE."

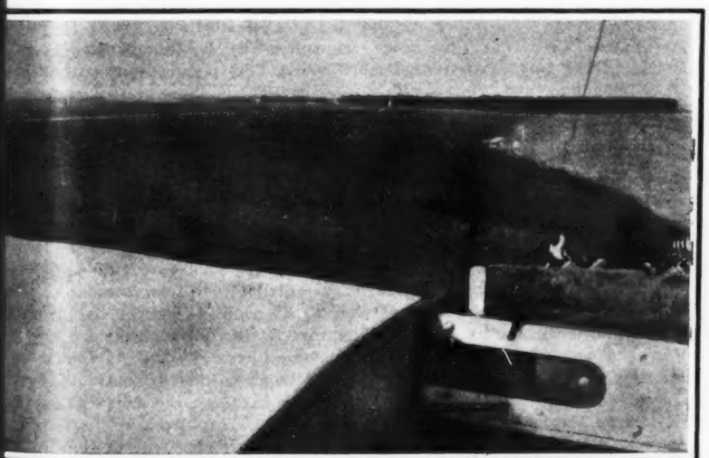
Now that it is possible for an aeroplane pilot to rry as many as two persons beside himself, various reign aviators have tried the experiment of carrying ad weight of various kinds in place of the second ssenger. The two photographs reproduced herewith ere taken by a photographer whom Latham recently ok aloft with his camera at Lonvercy, France. They ve a very good idea of the view one gets from a onoplane when in flight. In one of them, which was ken looking forward over the engine, the halo of e propeller can be seen. The same peculiar band curs across this halo as can be noted in the front ew of the propeller revolving, which formed the ontispiece of our SCIENTIFIC AMERICAN issue of Janury 8th. In that case the band appeared to be a adow, but in the present instance it seems to be an terruption in the halo, as the ground can be seen early at the band. At the upper edge of this band



THE AEROPLANE SHEDS AT LONVERCY AS VIEWED FROM THE ANTOINETTE MONOPLANE.

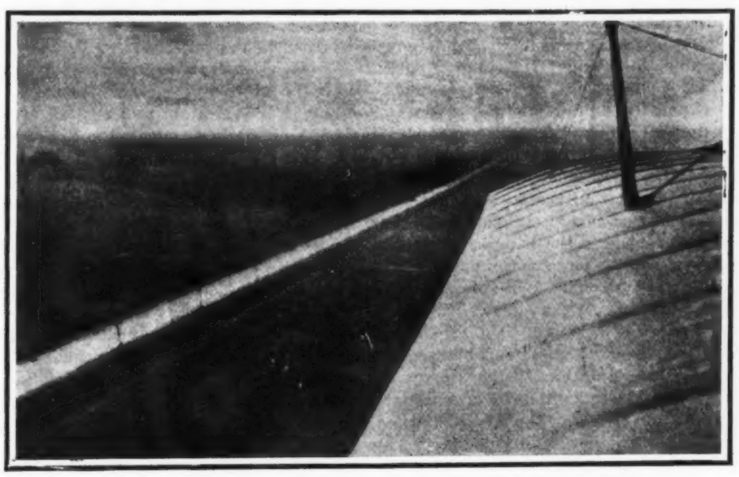


SIDE VIEW FROM THE MONOPLANE, SHOWING ANOTHER ANTOINETTE IN FRONT OF THE SHEDS.



VIEW LOOKING FORWARD FROM ANTOINETTE MONOPLANE IN FLIGHT.

The juncture of the main front longitudinals of the wings and the top of the 8-cylinder V-type motor can be seen in the foreground. Note also the halo of the propeller, and the biplane flying below in the distance.



SIDE VIEW ALONG REAR EDGE OF WING OF MONOPLANE.

The trussing of the wing can be seen in this photograph; also the upper main ribs which stand out through the cloth.

By courtesy of L'Illustration.

PHOTOGRAPHING FROM AN AEROPLANE.

Farman biplane is seen flying at a lower elevation. The second photograph was taken along the rear ge of the left wing of the monoplane. It shows a ad lined with trees on either side, above which the roplane is soaring.

Latham has also taken up a cinematograph and erator, and the moving pictures secured from the onoplane in flight are said to be very realistic.

EXPERIMENTS WITH WIRELESS WEATHER SIGNALS FROM THE NORTH ATLANTIC.

THE German and British meteorological offices concted conjointly, during the months of February, arch, and April, and again in August and September last year, two series of experiments in the wireless ansmission of weather indications from vessels travning the North Atlantic Ocean. The result of the st series of experiments may be summarized in the atement that, although the telegrams were not more equently unintelligible than occurs in ordinary telephing over land, yet the reported readings of the rometer were often erroneous and many of the mesges arrived too late to be of service for weather prediction. In the repetition of the experiments in August and September, the field of observation was confined to the region from 10 to 30 deg. of longitude west from Greenwich, because the experiments in the spring had shown that telegrams from points beyond the 30th meridian never arrived early enough to be of use to the Weather Bureau.

The observations were made at 7 A. M. and 6 P. M., Greenwich time. They were transmitted from the German steamers to the coast stations of the Marconi company in the form of two groups of five figures each, according to the scheme represented by the letters *BBWWD-PPPNN*. Here *BB* represent the barometric readings to the nearest millimeter, reduced to 32 deg. F. and the sea level, *WW* the direction and force of the wind, and *D* the date of the month, denoted by its unit figure alone. In the second group, the numbers *NN* indicate the name of the ship, *PPP* its position and the hour of observation. The German field of observation was divided into 500 sections of 1 degree in longitude and latitude, which for the morning observations were numbered from 0 0 0 to 499, while the same positions for the afternoon observations were designated by adding 500 in each case. For example, the following double group was received on September 23rd: 58852—16608. This is interpreted as follows: Steamer "Pennsylvania" (08), between 28 and 29 W. Long. and 49 and 50 N. Lat. on Sept. 22nd at 7 A. M. Greenwich time, barometer 758 millimeters, wind N. N. W., velocity of wind 1 to 3.

Forty-nine English steamers sent 568 telegrams during 181 trips, and 23 German steamers sent 276 telegrams on 74 trips. For the usefulness of the wireless system for the German Weather Bureau, the time of the arrival of the signals in Germany is of especial importance. Under the assumption that messages reaching a weather bureau at or before 10:30 A. M. are available for use, a period of 2½ hours can be allowed for the transmission of the morning observations and 15½ hours for the evening observations. During the 61 days of the experiment, 422 morning observations and 439 evening observations were transmitted. Of these, 188 of the evening observations, but only 31 of the morning observations, arrived in time to be of use in weather prognostication.

In regard to the most important point, i. e., the usefulness of wireless signals in the service of the Weather Bureau, Prometheus observes that during the month of August and September, not a single prediction of the Hamburg Weather Bureau was appreciably influenced by any wireless message. This result may, however, depend very largely upon the fact that during this period, as well as in the months of the spring experiments, an area of high pressure, extending westward from the British Islands, was very frequently observed. In this condition of the atmosphere, the distribution of pressure over the Atlantic Ocean exerts very little influence upon the coming weather in Germany. Even when the messages which had arrived too late for the compilation of the weather predictions were subsequently taken into account, in the great majority of cases no important deviation was produced from the distribution of pressure over the ocean, as originally deduced from barometric observations in Iceland and the Azores. Nevertheless, the timely arrival of the evening messages might often be of great value, for example, in those cases in which a minimum of pressure has moved from the ocean to the British Islands during the night, when the prediction of the subsequent course of this minimum would be greatly facilitated by a knowledge of its position on the preceding evening. In the present state of wireless telegraphy a similiar utilization of the morning observations, which would be of still greater value, is unfortunately not to be thought of. On the whole, the advantages to be expected from the employment of wireless telegraphy in the German Weather Service are yet too small to warrant any further experiments in the wireless transmission of observations made at sea. For the permanent introduction of the wireless system, we must wait until the progress of wireless telegraphy shall have made it possible for vessels to extend their radius of action without increase of expense.

FLYING IN THE FUTURE.*

THE MACHINE AND THE AVIATOR SOME YEARS HENCE.

BY CHARLES CYRIL TURNER.

What will the flying machine of the future be like? That there will be considerable specialization of machines for specific purposes is certain, and, while some authorities are convinced that the monoplane principle is a good one, there is obviously material for much interesting differentiation. This differentiation will, in the main, respond to certain demands. We can clearly foresee development with both monoplane and biplane.

The racing aeroplanes will probably be monoplanes with comparatively small lifting surface, high speed giving the necessary lifting power. The racing aeroplane will not carry a great weight, and the power of the engine will be required for driving at a great speed without more waste of energy than is unavoidable. It is, of course, an axiom that the greater the speed, the less the waste of power. Monoplanes will very probably develop into a permanent racing type.

It is unwise to jump hastily into advocacy of any one type. There has not yet been a scientific test of the various types of machines. Until we classify machines according to different grades, such as area of plane, method of control, weight, etc., and have class competitions on scientific lines, we shall not advance sensibly toward the elimination of the less fit.

A hasty judgment on the basis of the Blackpool and Doncaster meetings would have placed the Farman biplane at the top at both, the Antoinette as the best monoplane at Blackpool, and the Blériot as the best monoplane at Doncaster. But there was no extended trial of other machines at these meetings. At Rheims many machines flew, but there was no classified testing.

Major Baden-Powell, reporting in the Journal of the Aeronautical Society on the Rheims meeting, found that the Curtiss biplane and the Blériot monoplane were the speediest, the Antoinette second, and the Wright third. The Voisin biplane was the slowest of all. Of these machines the Blériot was the heaviest in relation to size of sustaining plane, the Wright was the lightest, the Antoinette nearly as light as the Wright.

The Blériot carried about 5 pounds per square foot of the area, the Wright less than 2 pounds, the Antoinette 3 pounds, the Curtiss 2½ pounds. Thus the heaviest and the lightest of the machines were among the fastest.

Perhaps the more exhaustive tests which will be made this year will elucidate some of these points.

I think the near future will see machines in which three or four passengers can be carried, and in which the control can be in the hands of two pilots. Sooner or later we shall get the machine attempted with two motors instead of one. And quite certainly we shall have the machine with variable lifting surface and variable power.

We know that an aeroplane can descend safely onto water. Latham did that in his attempt to cross the Channel. Soon we shall have machines that can ascend from water.

It is not altogether uninstructive to pay attention to the imagination of the novelists when they are thinkers of the caliber of Mr. Kipling and Mr. Wells.

The imagination of Mr. Wells in "When the Sleeper Wakes" gives a view of the world some 300 years hence, when flying machines are supposed to have become the ordinary instruments of locomotion. Mr. Wells describes two kinds of these machines. One is a big aeroplane, carrying some hundreds of passengers; the other is a small, very active aerial "top," carrying but one or two persons, and buzzing about like a fly.

Mr. Kipling shows us the transatlantic mails carried by airship driven by powerful motors, and equipped with a remarkable rudder, called the "Magniac," after its inventor.

"The rudder that assured us the dominion of the unstable air and left its inventor penniless and half blind. It is calculated to Castelli's 'gull-wing' curve. Raise a few feet of that all but invisible plate three-eighths of an inch and she will yaw five miles to port or starboard ere she is under control again. Give her full helm and she returns on her track like a whip-lash. Cant the whole forward—a touch on the wheel will suffice—and she sweeps at your good direction up or down. Open the complete circle and she presents to the air a mushroom-head that will bring her up all standing within a half mile."

Nobody but Mr. Kipling could have written that. It should be an inspiration to the inventor. This airship is gas-lifted, and the gas is kept well in hand by the use of "Fleury Ray," which reduces it to liquid and again to fully efficient gas at will. A wonderful story, if only for the aeronautical terms employed, many of which will come into use in our time.

Mr. Kipling, by the way, looking back at our own feeble efforts at flight, talks with scorn of "the days when men flew wooden kites over oil-engines."

We have spoken of possible developments of the flying machine, but there are and will remain limitations. One limitation is that of cost. The cost of an aeroplane is principally that of the motor, and with types becoming standardized the price of an aeromotor will probably come down to $1,000 or so. An aeroplane costs from $2,000 to $7,500.

Then we have the prospect of a considerable degree of standardization of parts, permitting the cost of manufacture to be considerably reduced. Probably the cost of a flying machine, power for power, will be no more than two-thirds of that of a motor car. On the score of cost of machines, then, there is nothing to prohibit a great extension of the community of flyers. But this cheapening depends upon the creation of a certain demand, and the demand depends first of all upon facilities for flying.

But one other expense has been mentioned—that of depreciation. Wet weather plays havoc with flying machines, and since the life of the pilot depends upon the reliability of each single wire, there will have to be some development in the way of weather-proof machines. We must have metal work that does not rust, and fabric that does not rot. The pilot will have to take more care of his planes and framework than he did at Doncaster and Blackpool. Otherwise a machine that cost $5,000 will depreciate in value 50 per cent in a month.

As to facilities for flying practice, the use of public commons and parks will, of course, be denied to the aeroplanist. The solution of the problem will be found in a rapid extension of the practice of aeronautical societies acquiring grounds for flight, and then swift progress from this beginning. With the extension of flying, societies of flyers will spring up everywhere, and will acquire private ground, just as for motor, cycle, and horse racing private ground has for a long time past been preserved. These flying grounds will be maintained by the subscriptions of members, and by gate money.

It is natural and necessary to start with your private aeroplaning grounds. But once your aviator is in the air he will fly beyond. There may be flights from one ground to another, and various inter-club competitions.

Very early a demand will spring up for maps showing suitable descending places, and municipalities will be asked to mark out available lands. There is already rivalry among the watering places and holiday resorts in the matter of providing facilities for aviation. Frequented routes will have landing and supply stations at intervals of ten miles or so.

I do not believe that we need be dismayed because the flying machine at present requires a long start on the ground. There are many railway stations in London to which the public only have access by ascending many stairs or descending in lifts. Yet they are used by the patient, long-suffering public. With the extension of flying we shall have plenty of suitable starting and alighting places. And that is not taking account of the possibility of improvements in machines.

It is common to hear the numerous limitations of the flying machine urged against it, but I think we might with reason remember how short is the time during which men have flown, and how recently it is that they have been able to gain experience in the air. Progress has been very rapid in the past two years, and great developments in the motor, in aeroplane construction, as well as in dirigible ballooning, are imminent.

Finding the way in the air is difficult. Needless to say, the aeronaut must take a compass. The best form of compass is the prismatic, by which directions can be taken with very great accuracy all the time fixed objects on the earth are visible. This compass should have a dial covered with luminous material visible at night. For employment upon aeroplanes it is necessary to have a compass immune from the influence of the magneto of the motor. This disturbing influence will probably be overcome in the same way as on the torpedo boats. There the compass is greatly interfered with by the machinery, but tests are made and the amount of deflection ascertained. Then magnets are placed in such a position as to correct the variation.

A gyroscope compass may be possible. Once a gyroscope has been set spinning at a sufficient rate in a certain plane it will remain in that plane. Start it spinning in the plane that runs north and south and it will remain in it, not subject to magnetic or other disturbances.

Keeping a straight course is possible all the while land is in sight. For it is simply necessary to take your line with two fixed objects. Naturally, when one pilot has to do all this and attend to the machine and motor, he has not any leisure to speak of.

We have seen that an airship can, if its velocity be superior to that of the wind, make for its destination with due allowance for drifting. If you cannot see the earth, however, and cannot take a meridian, you may go far out of your course. A little instrument has been brought out to enable the true direction of an airship to be readily determined at any time, that is to say, the direction resulting from the forward motion and any drifting motion which from any cause may be set up, but it is only of use when the ground is visible or when the aeronaut is fairly certain of the direction and velocity of the wind. Flying by night or over clouds presents difficulties unless the balloonist or aeroplanist can see fixed objects. He cannot tell how much he may be drifting astray on a big current of air.

To balloonists, whether in a spherical or a dirigible balloon, an electric indicator on the trailing rope is useful at night. The drag of the trail rope along the ground causes the end in the car to make contact with an electric indicator, which at once rings a bell, warning the aeronaut, when he may not be able to see, that he is near the ground, and that it may be necessary to discharge ballast in order to avoid striking something in the dark.

Special maps are necessary for aerial navigation. It is very difficult to recognize familiar country from above, and the ordinary map is of very little use in informing the aeronaut of his whereabouts if he is over strange country. The familiar landmarks are not recognizable. With a map on a scale of half an inch to the mile, showing the lines of the roads and the shapes of the villages, it is often easy enough to ascertain the locality, but the aeronaut travels swiftly, and a full equipment of half-inch scale maps would be a serious item in the weight of his load. Moreover, he is often above clouds for a considerable period, and then when he views the earth again it is very difficult and frequently impossible to pick up the locality by a study of the map. The aeronaut in the flying machine or the dirigible balloon is more favorably placed than in the ordinary balloon. He knows his direction approximately, although he is, as we have seen, often unable to make proper allowance for the drifting effect of the wind, and if caught by varying currents or by storms above the clouds he easily loses track of the course of his flight.

"Relief" maps are of little use and there will be need for the construction of large distinctive ground marks for day and lights for night time at distances about ten miles or so apart indicating by number or shape the localities. These marks would of course correspond with marks on the chart. They could be different in color and in shape, and each county might have its special mark on the basis possibly of the motor-car registration letters.

Zeppelin proposes maps showing different heights by color with streams, marshes, and woods indicated as influencing the static equilibrium of the airship. The scale he suggests is three miles to the inch, but this, of course, is rather for balloonists than for aeroplanists. Color is the main consideration, and the color, I am convinced by my own experience, should approximate to the colors of the landscape as seen from above. The roads should be in white, the water blue, the fields light green, woods a darker green, habitations gray, railways black, very much as these general features appear from above. Roads and the lines with which they converge on a town, taken in conjunction with railways and water, I have always found are the surest guides to locality.

Combined with that of marks to guide the aerial traveler in locality and direction is the question of conveying useful information to him. It will often be of great importance to him to know the strength and exact direction of the wind. It may not be possible for him to ascertain these with absolute accuracy while he is in flight, by his own observations. The

* Journal of the Society of Arts.

German Aerial Navy League has brought forward a useful idea in this connection, suggesting special lighthouses. These are to send a long beam of light in the direction in which the wind is blowing. But to make the service thus rendered more particular, would it not be better to have a long white indicator with a conspicuously painted arrow, and some method of marks to indicate the strength of the wind?

We turn to Mr. Kipling for guidance, and we get a picture of an aerial world illuminated from below by colored beams that pierce through thick strata of clouds.

"Bristol and Cardiff double lights (those statelily-inclined beams over Severnmouth) are dead ahead of us; for we keep the southern winter route. Coventry Central, the pivot of the English system, stabs upward once in ten seconds its spear of diamond light to the north, and a point or two off our starboard bow. The Leek, the great cloud breaker of St. David's Head, swings its unmistakable green beams 25 degrees each way. There must be half a mile of fluff over it in this weather, but it does not affect the Leek. 'Our planet's overlighted, if anything,' says Capt. Purnall, at the wheel."

TURBINES IN WARSHIPS.

THEIR PRESENT STATUS.

THE marine steam turbine is in a very uncertain position as far as its future design is concerned. Excellent as it is in many ways there is much about it that is not entirely satisfactory, and considerable changes must be looked for before long in the technical features of the design. It is, at present—we speak generally of both the Parsons and Curtis types, the only two that offer serious probabilities of survival—well proved to be economical, its durability is beyond question, while its intrinsic suitability for marine propulsion may be gaged from the fact that there is now somewhat over 6 million horse-power at work or under construction. Nevertheless, could the answer be freed from all bias, it would be difficult to say exactly what is really the best arrangement of turbine machinery for warship work. That the British Admiralty is uncertain is shown by the widely differing types of arrangements that we find in the "Amethyst," "Dreadnought," "Bristol," "Newcastle," and "Orion." The German and United States Admiralty Engineering Departments are equally uncertain what type of machinery to install. Each is adopting Parsons turbines on four shafts, Curtis on two or three, or reciprocating engines. Generally speaking, the difference between three and four shafts is settled by the question of horse-power and revolutions, or, to go into greater detail, by initial blade height in the turbine.

But assume the same class of ship—a "Neptune" for example, of 25,000 horse-power and 21 knots—what is the best type that can be adopted? When the "Dreadnought" was built there was no question—other types had not been developed—but now matters are different. To anyone who has seen the stern of the "Vanguard," with her four 9-foot screws, and compared it with that of the "St. Paulo"—both vessels are being completed at Barrow at the present time—with two of 18-foot diameter, there can be no doubt of the greater advantages of the twin screw. But what of the turbine? Triple screws have never been favored in this country, but they are being tried in the new German turbine battleship, which in this particular follows previous practice. Four shafts appear to complicate a stern very much, but for very fine ships, where the wing propellers can be placed far ahead of the inner ones, the results obtained have been good. When the screws have not been sufficiently separated the results have been poor—very poor. The main objections that can be raised to most existing warship arrangements are the use of cruising turbines and the adoption of separate astern turbines. The former are useless weight at full speed, besides being a most unnecessary brake on the main turbines; at low speeds the value in lowering consumption ranges from practically *nil* in large vessels to a measurable, but very small, amount in destroyers, and only in these because of the extraordinary range of power at which such vessels are steamed. The same weight in either type of ship applied to fuel would be of far greater value and reduce the complication. Separate astern high-pressure turbines are just as bad. They brake the ahead turbine, they are relatively very heavy, and add equally to the complication. Is it really necessary to reverse all the shafts of a four-shaft vessel? The "Mauretania" has only two shafts so fitted out of four, and there are various other vessels like her. Quite apart from many debatable points of detailed mechanical design, these features alone justify our asking seriously if we have really got the best design? Are matters not in a state of uncertainty because of the patent position and a desire to avoid additional complications or royalties? Or is it, perhaps, that having adopted one style, there is some hesitation in certain quarters to blend with it some of the salient features of another? Much more important to the navy or to those interested in steamship propulsion generally would be an unbiased answer to the question, Would it not give us a better engine if we did blend the better features of the two turbine systems now in vogue? In the newer large ships of the navy, cruising turbines are abandoned, but separate high-pressure astern turbines remain. The high-pressure ahead turbine is lengthened by one stage of blading, which is meant to act as a cruising turbine below certain speeds; for higher speeds the steam is by-passed to the second or third stage. The blades in this initial stage are necessarily short and relatively inefficient. Can this be called a good mechanical system for obtaining low-power economy? Is it likely to remain as a permanent feature in turbine design? A four-shaft "Neptune" has four propellers, about 9 feet diameter, revolving at 320 revolutions. If fitted with three shafts the screws would be 10 feet 6 inches diameter, and revolve at 280 revolutions, while twin screws would require to be 13 feet diameter and revolve at 225. Suppose we made them 14 feet instead, and ran them at 210, could we not get a better propeller efficiency than with four of 9 feet diameter where the wing screws, owing to the full nature of the ship, must interfere with the inner screws. There is no doubt that this is possible. Again we ask what of the turbine? Take the existing low-pressure turbine, and increase the mean diameter in the ratio of 320/210 and reduce the blade height to give the same area through the blades as before. This turbine will not be quite so efficient, owing to relatively greater leakage over the blade tips, but the blades will be shorter, and therefore narrower and of smaller pitch. In the same total length it will be possible to add the requisite few rows to keep the economy of the low-pressure turbine the same. The difficulty lies in the arrangement of the high-pressure portion. We have seen how the propeller efficiency is improved and the efficiency of the low-pressure portion maintained as before, even a slight reduction in the previous efficiency of the high-pressure portion—only 50 per cent of the power—might be allowed and still leave a gain in total efficiency. The mechanical features of an impulse high-pressure portion composed of either one or two velocity compounded stages present some little difficulty whether the revolving blades be mounted on a drum or on disks, as in the Curtis design. But such an arrangement allows the use of only one cylinder for each unit. Nozzles can easily be shut off independently if cruising conditions are required, there is no separate astern cylinder, and no mazed complication of valves to handle as in case where there are two cruising turbines in series, and one side is required to go ahead and the other astern. The practical difficulty of having a very heavy rotor to handle is certainly an objection but not a serious one, but the advantage of two shafts over three or four with all the bearings, glands, and stuffing-boxes is a very real one—to the man in charge. If the high-pressure modification can be carried out efficiently there will be a gain to the owner of the installation too.

There is no doubt that there is a strong tendency towards this development of the twin-screw turbine at present. All the Argentine destroyers are to have twin screws, all the latest German destroyers have, and they have proved amply successful. Is it certain that the five-cylinder complication on three shafts as adopted in all the 1908 and 1909 British destroyers is really the best? If not, it is hard to see why. One difficulty in adopting twin screws lies in the case of limited drafts of water, then three may have to be used. Even so, is not the single-cylinder type of turbine—one complete unit per shaft—likely to be the ultimate solution? There is nothing strikingly novel in the combination of one type for the high-pressure end of the turbine and another type for the low pressure. The system has been widely adopted for land turbines—originally by Mr. Westinghouse in America, we believe—but for marine work there are mechanical difficulties to overcome. Once these by no means insuperable points have been arranged for, this system is practically sure to replace the more costly and complicated one to which, however, engineers must always award full credit for being that which originally demonstrated the possibility of the application of turbines to ship propulsion.—The Engineer.

THE ENERGY OF A STEAM BOILER.

THE explosion of a boiler is not an instantaneous action, but a series of well-defined but rapidly-succeeding operations. If the break occurs below the water line, it is possible that no explosion will ensue, as the situation of the break is not favorable for the production of water hammer, and the boiler will relieve itself of its pressure by the water issuing out first. But if the break be above or near the water line, the circumstances are favorable to the production of water hammer, and a violent explosion may occur.

The method of explosion, in most instances, seems to be the opening of a small orifice at a point where the resistance offered by the material is less than the stress to which it is subjected, followed by an outrush of steam or water, or both; the extension of the rupture to the adjoining parts when these parts become too weak to sustain the increased stress which the break already made puts upon them, this operation being so sudden that sufficient time is not allowed for the gradual escape of the inclosed fluids; and the boiler is torn violently into fragments, and distributed far and wide by the steam generated from the liberated water.

An explosion does not ensue if the parts adjacent to the initial rupture possess sufficient strength, and it is probable that explosions do not occur unless the strength of the boiler is quite uniform, but less than that required to sustain the pressure. Local weakness is a safety valve that permits a rupture, and insures again a general disrupture.

Minor defects surrounded by strong parts merely relieve the pressure; but a long seam weakened by corrosion or "burning" of the lap, a considerable area of plate thinned by corrosion or weakened by overheating, or an extended crack, may be the occasion of a disastrous explosion.

The energy in a cubic foot of highly-heated water is equal to the energy in a pound of gunpowder. Most of the energy in a steam boiler under pressure is contained in the water, and only a relatively small amount of the energy in the steam. Take, for instance, the case of a horizontal tubular boiler carrying 150 pounds pressure, and having 160 cubic feet of water space and 80 cubic feet of steam space. The water weighs $160 \times 62.4 = 9{,}984$ pounds, and the steam weighs $80 \times 0.3671 = 29.37$ pounds.

The energy in each pound of water at 150 pounds pressure that would be liberated by explosion and expansion down to 212 deg. F. is 11,823.4 foot-pounds, and the energy in each pound of steam at the same pressure is 134,521.2 foot-pounds. The total energy in the water is therefore, $9{,}984 \times 11{,}823 = 118{,}040{,}832$ foot-pounds, and the total energy in the steam is $29.37 \times 134{,}521 = 3{,}950{,}882$ foot-pounds. The energy in the steam is consequently less than 4 per cent of that in the water. The water is the more dangerous content of the boiler.

The total energy in the water and steam is $118{,}040{,}832 + 3{,}950{,}882 = 121{,}991{,}714$ foot-pounds. If the boiler weighs, say, 10,000 pounds, and if all of this energy were expended in an explosion in projecting the boiler vertically, then, neglecting the friction of the air, the boiler would rise to a height of 12,199 feet, or over two miles.—Bulletin of the Fidelity and Casualty Company.

According to a contemporary, Prof. Osann holds that the advantages of the dry blast are mainly confined to furnaces that do not run well under ordinary conditions, but consume an unduly large amount of coke, the usual cause being that the sectional area of the furnace has become lessened. In view of this circumstance and of the high cost of fitting up a large dry-air plant, he recommends that, for a group of furnaces, the drying plant should be merely large enough to supply one of them—the largest, if there be any difference in their size—with dry blast, arrangements being made for coupling up this plant to any of the blowing engines. By using the drying plant only when any of the furnaces begin to go wrong, the deterioration may be retarded and prevented from becoming chronic. This would reduce the cost of dry blast considerably; and, by making provision for admitting controllable amounts of steam into the dry blast, it would also be possible to remedy other working defects of the furnaces.

PROGRESS IN WIRELESS TELEGRAPHY.—II.*

A NOBEL PRIZE LECTURE.

BY GUGLIELMO MARCONI.

Concluded from Supplement No. 1782, Page 142.

A RESULT of scientific interest which I first noticed during the tests on the steamship "Philadelphia," and which is a most important factor in long-distance radio-telegraphy, was the very marked and detrimental effect of daylight on the propagation of electric waves at great distances; the range by night being usually more than double that attainable during daytime.[1] I do not think that this effect has yet been satisfactorily investigated or explained. At the time I carried out the tests I was of opinion that it might be due to the loss

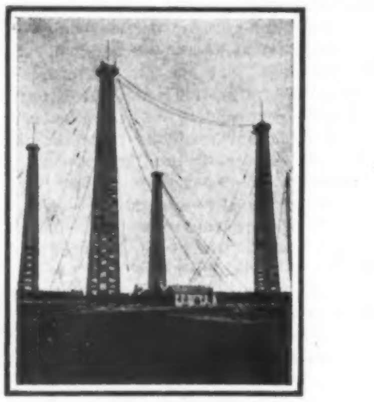


FIG. 15.

of energy at the transmitter, caused by the dis-electrification of the highly-charged transmitting elevated conductor under the influence of sunlight.

I am now inclined to believe that the absorption of electric waves during the daytime is due to the ionization of the gaseous molecules of the air affected by ultra-violet light, and as the ultra-violet rays, which emanate from the sun, are largely absorbed in the upper atmosphere of the earth, it is probable that the proportion of the earth's atmosphere which is facing the sun will contain more ions or electrons than that portion which is in darkness, and therefore, as Sir J. J. Thomson has shown[2], this illuminated and ionized air will absorb some of the energy of the electric waves. Apparently, the length of wave and altitude of electrical oscillations have much to do with this interesting phenomenon, long waves and small amplitudes being subject to the effect of daylight to a much lesser degree than short waves and large amplitudes. According to Professor Fleming, the daylight effect should be more marked on long waves, but this has not been my experience. Indeed, in some very recent experi-

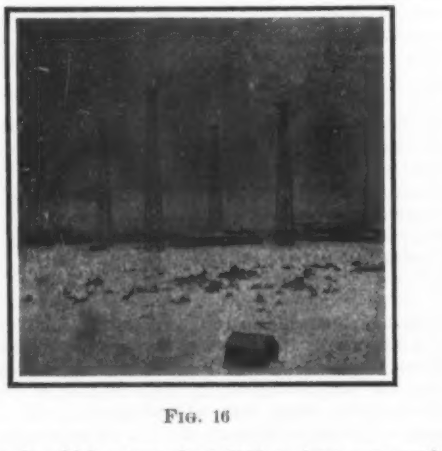


FIG. 16

ments, in which waves about 8000 m. long were used, the energy received by day was usually greater than at night. The fact remains, however, that for comparatively short waves, such as are used for ship communication, clear sunlight and blue skies, though transparent to light, act as a kind of fog to these waves. Hence, the weather conditions prevailing in England, and perhaps in this country (Sweden), are usually suitable for wireless telegraphy.

During the year 1902 I carried out some further tests between the station at Poldhu and a receiving installation erected on the Italian cruiser "Carlo Alberto," kindly placed at my disposal by H. M. the King of Italy.[3] During these experiments the interesting fact was observed that even when using waves as short as 1,000 feet intervening ranges of mountains, such as the Alps or Pyrenees, did not, during the night time, bring about any considerable reduction in the distance over which it was possible to communicate. During daytime, unless much longer waves and more power were used, intervening mountains greatly reduced the apparent range of the transmitter. Messages and press dispatches of considerable length were received from Poldhu at the positions marked on the map, which map is a copy on a reduced scale of the one accompanying the official report of the experiments—Fig. 16.

With the active encouragement and financial assistance of the Canadian government, a high-power station was constructed at Glace Bay, Nova Scotia, in order that I should be able to continue by long-distance tests with a view to establishing radio-telegraphic communication on a commercial basis between England and America.[4] On December 16th, 1902, the first official messages were exchanged at night across the Atlantic, between the stations at Poldhu and Glace Bay—Figs. 15 and 16. Further tests were shortly afterward carried out with another long-distance station at Cape Cod in the United States of America, and under favorable circumstances it was found possible to transmit messages to Poldhu, 3,000 miles away, with an expenditure of electrical energy of only about 10 kilowatts.

In the spring of 1903 the transmission of press messages by radio-telegraphy from America to Europe was attempted, and for a time the London Times published, during the latter part of March and the early part of April of that year, news messages from its New York correspondent sent across the Atlantic without the aid of cables. A breakdown in the insulation of the apparatus at Glace Bay made it necessary, however, to suspend the service, and unfortunately further accidents made the transmission of messages uncertain and unreliable. As a result of the data and experience gained by these and other tests which I carried out for the British government, between England and Gibraltar, I was able to erect a new station at Clifden in Ireland, and enlarge the one at Glace Bay in Canada, so as to enable me to initiate, in October, 1907, communication for commercial purposes across the Atlantic between England and Canada. Although the stations at Clifden and Glace Bay had to be put into operation before they were altogether completed, nevertheless comunication across the Atlantic by radio-telegraphy never suffered any serious interruption during nearly two years until, in consequence of a fire at Glace Bay this autumn, it has had to be suspended for three or four months. This suspension has not, however, been altogether an unmitigated evil, as it has given me the opportunity of installing more efficient and up-to-date machinery.

The arrangements of elevated conductors or aerials which I have tried during my long-distance tests are shown in Figs. 17, 18, and 19.[5] The aerial, shown in Fig. 19, consisted of a nearly vertical portion in the middle, 220 feet high, supported by four towers, and attached at the top to nearly horizontal wires, 200 in number and each 1,000 feet long, extending radially all round, and supported at a height of 180 feet from the ground by an inner circle of 8, and an outer circle of 16, masts. The natural period of oscillation of this aerial system gave a wave length of 12,000 feet. Experiments were made with this arrangement in 1905, and with a wave length of 12,000 feet, signals, although very weak, could be received across the Atlantic by day as well as by night. The system of aerial I finally adopted for the long distance stations in England and Canada is shown in Fig. 20. This arrangement not only makes it possible efficiently to radiate and receive waves of any desired length, but also tends to confine the main portion of the radiation to a given direction. The limitation of transmission to one direction is not very sharply defined, but the results obtained with this type of aerial are nevertheless exceedingly useful.

Many suggestions respecting methods for limiting the direction of radiation have been made by various workers, notably by Prof. F. Braun, Prof. Artom, and Messrs. Bellini and Tosi. In a paper read before the Royal Society in London in March, 1906[6], I showed how it was possible by means of horizontal aerials to confine the emitted radiations mainly to the direction of their vertical plane, pointing away from their earthed end. In a similar manner it is possible to locate the bearing or direction of a sending station. The transmitting circuits at the long-distance stations are arranged in accordance with a comparatively recent sys-

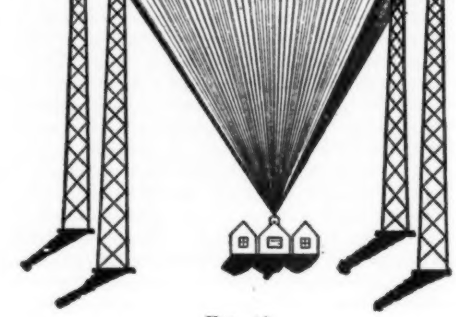


FIG. 17.

tem for producing continuous or slightly damped oscillations, which I referred to in a lecture before the Royal Institution of Great Britain on March 13th, 1908. An insulated metal disk A, Fig. 21, is caused to rotate at a high rate of speed by means of an electric motor or steam turbine. Adjacent to this disk, which I will call the middle disk, are placed two other disks C' and C'', which may be called polar disks, and which are also revolved. These polar disks have their peripheries very close to the surface or edges of the middle disk. The two polar disks are connected by rubbing contacts to the outer ends of two condensers K, joined in series, and these condensers are also connected through suitable brushes to the terminals of a generator, which should be a high-tension continuous current generator. On the middle disk a suitable brush or rubbing contact is provided, and between this contact and the middle point of the two condensers an oscillating circuit is inserted, consisting of a condenser E in series with an inductance, which last is inductively connected with the radiating antennæ. The apparatus works probably in the following manner: The gen-

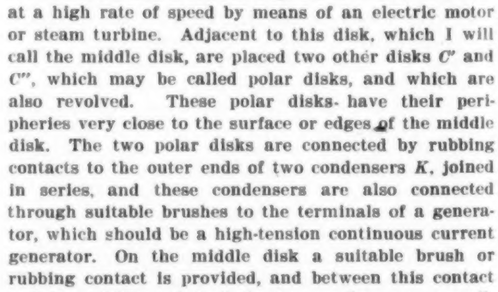


FIG. 18.

erator charges the double condenser, making the potential of the disks, say C' positive and C'' negative. The potential, if high enough will cause a discharge to pass across one of the gaps, say, between C' and A. This charges the condenser E through the inductance F, and starts oscillations in the circuit. The charge F in swinging back will jump from A to C'', the potential of which is of opposite sign to A, the dielectric strength between C' and A having meanwhile been restored by the rapid motion of the disk, driving away the ionized air. The condenser E therefore discharges and recharges alternatively in reverse directions, the same process going on so long as energy is supplied

* Address delivered in Stockholm by Mr. Marconi on the occasion of the awarding of his share of the Nobel prize.

[1] See Proceedings of the Royal Society, Vol. LXX., "A Note on the Effect of Daylight upon the Propagation of Electromagnetic Impulses." G. Marconi, June 12th, 1902.

[2] See Philosophical Magazine, August, 1902, Ser. 6, Vol. IV., p. 253, J. J. Thomson, "On Some Consequences, etc."

[3] See "Revista Marittima," Rome, October, 1902.

[4] See paper read before the Royal Institution of Great Britain by G. Marconi, March 3rd, 1905.

[5] See also lecture before the Royal Institution of Great Britain by G. Marconi, March 13th, 1908.

[6] "On Methods whereby the Radiation of Electric Waves may be Mainly Confined, etc." "Proceedings" of the Royal Society, A Vol., 77, 1906.

to the condensers K by the generator H. It is clear that the discharges between C' and C'' and A are never simultaneous, as otherwise the center electrode would not be alternatively positive and negative.

The best results have, however, been obtained by an arrangement, as shown in Fig. 22, in which the active surface of the middle disk is not smooth, but consists of a number of regularly spaced copper knobs or pegs, at the ends of which the discharges take place at regular intervals. In this way it is possible to cause the groups of oscillations radiated to reproduce a high and clear musical note in a receiver, and thereby it is easier to differentiate between the signals emanating from the sending station and noises caused by atmospheric electrical discharges. By this method very efficient resonances can be also obtained in appropriately designed receivers.

With regard to the receivers employed, important

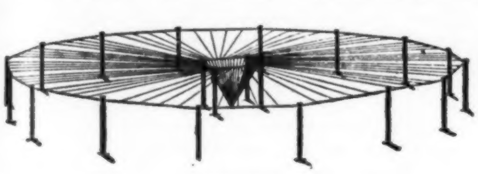


FIG. 19.

changes have taken place. By far the larger portion of electric wave telegraphy was, until a few years ago, conducted by means of some form or other of coherer, or variable contact either requiring tapping or self-restoring. At the present day, however, I might say that in all the stations controlled by my company my magnetic receiver is almost exclusively employed, Fig. 23. This receiver is based on the decrease of magnetic hysteresis which occur in iron when under certain conditions this metal is subjected to the effects of electrical waves of high frequency. It has recently been found possible to increase the sensitiveness of these receivers, and to employ them in connection with a high-speed relay, so as to record messages at great speed.

A remarkable fact, not generally known, in regard to transmitters is that none of the arrangements employing condensers exceeds in efficiency the plain elevated aerial or vertical wire discharging to earth through a spark gap, as used in my first experiments, Figs. 2 and 3 (*ante*). I have recently been able to confirm the statement made by Prof. Fleming in his book, "The Principles of Electric Wave Telegraphy," 1906, page 555, that with a power of 8 watts in the aerial it is possible to communicate to distances of over 100 miles. I have also found that by this method it is possible to send signals 2,000 miles across the Atlantic with a smaller expenditure of energy than by any other method known to myself.

The only drawback to this arrangement is that unless very large aerials are used, the amount of energy which can be efficiently employed is limited by the potential, beyond which brush discharges and the resistances of the spark gap begin to have a deleterious effect. By means of spark gaps in compressed air and the addition of inductance coils placed between the aerial and earth, the system can be made to radiate very pure and slightly damped waves, eminently suitable for sharp tuning. In regard to the general working of wireless telegraphy, the widespread application of the system and the multiplicity of the stations have greatly facilitated the observation of facts not easily explainable. Thus it has been observed that an ordinary ship station utilizing about half a kilowatt of electrical energy, the normal range of which is not greater than 200 miles, will occasionally transmit messages across a distance of over 1,200 miles. It often occurs that a ship fails to communicate with a nearby station, but can correspond with perfect ease with a distant one.

On many occasions last winter the steamship "Car-

FIG. 20.

onia," of the Cunard Line, carrying a station utilizing about half a kilowatt, when in the Mediterranean off the coast of Sicily, failed to obtain communication with the Italian stations, but had no difficulty whatsoever in transmitting and receiving messages to and from the coasts of England and Holland, although these latter stations were considerably more than 1,000 miles away and a large part of the continent of Europe and the Alps lay between them and the ship.

Although high power stations are now used for communicating across the Atlantic, and messages can be sent by day as well as by night, there still exist short periods of daily occurrence during which transmission from England to America, or *vice versa*, is difficult. Thus, in the morning and evening, when, in consequence of the difference in longitude, daylight or darkness extends only part of the way across the ocean, the received signals are weak, and sometimes cease altogether. It would almost appear as if electric waves, in passing from dark space to illuminated space, and *vice versa*, were reflected in such a manner as to be diverted from their normal path. It is probable that these difficulties would not be experienced in telegraphing over equal distances north and south, on about the same meridian, as in this case the passage from daylight to darkness would occur almost simultaneously over the whole distance between the two points.

Another curious result, on which hundreds of observations continued for years leave no further doubt, is that regularly, for short periods, at sunrise and sunset, and occasionally at other times, a shorter wave can be detected across the Atlantic in preference to the longer wave normally employed. Thus, at Clifden and Glace Bay, when sending on an ordinary coupled circuit arranged so as simultaneously to radiate two waves, one 12,500 feet, and the other 14,700 feet, although the longer wave is the one usually received at the other side of the ocean, regularly about three hours after sunset at Clifden and three hours before sunrise at Glace Bay the shorter wave alone was received with remarkable strength, for a period of about one hour. This effect occurred so regularly that the operators tuned their receivers to the shorter wave at the times mentioned as a matter of ordinary routine.

With regard to the utility of wireless telegraphy, there is no doubt that its use has become a necessity for the safety of shipping, all the principal liners and warships being already equipped, its extension to less important ships being only a matter of time, in view of the assistance it has provided in cases of danger. Its application is also increasing as a means of communicating between outlying islands, and also for the ordinary purposes of telegraphic communication be-

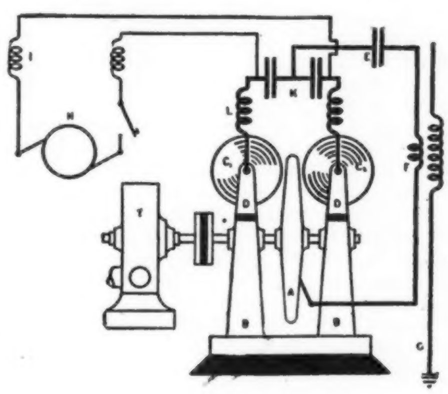


FIG. 21.

tween villages and towns, especially in the colonies and in newly-developed countries. However great may be the importance of wireless telegraphy to ships and shipping, I believe it is destined to an equal position of importance in furnishing efficient and economical communication between distant parts of the world, and in connecting European countries with their colonies and with America. As a matter of fact, I am at the present time erecting a very large power station for the Italian government at Coltano, for the purpose of communicating with the Italian colonies in East Africa and with South America.

Whatever may be its present shortcomings and defects, there can be no doubt that wireless telegraphy even over great distances has come to stay, and will not only stay, but continue to advance. If it should become possible to transmit waves right round the world, it may be found that the electrical energy traveling round all parts of the globe may be made to concentrate at the antipodes of the sending station. In this way it may some day be possible for messages to be sent to such distant lands by means of a very small amount of electrical energy, and therefore at a corresponding small expense. But I am leaving the regions of fact, and entering the regions of speculation, which, however, with the knowledge we have gradually gained on the subject, promise results both useful and instructive.

[2] "Proceedings" of the Royal Society. "Note on a Magnetic Detector of Electric Waves." G. Marconi, Vol. LXX., 1902, page 341.

BAMBOO PAPER.

CONSUL S. C. REAT, of Tamsui, furnishes the following information concerning Formosan bamboo pulp and the manufacture of paper therefrom in Japan:

Will the world's future supply of paper pulp be derived from the bamboo forests of the tropics instead of being drawn from the forests of the temperate zones? A tentative affirmative answer to this question could be made by the Mitsu Bishi Paper Mill Company, which has recently made very satisfactory experiments with bamboo pulp at its scientific station near Kobé, Japan.

This company has the utmost confidence in the results of its experiments with bamboo pulp. It has been granted a perpetual lease of 8,000 acres of bamboo forest in Formosa, and is now engaged near Kagi in installing the machinery for a plant with a capacity of 300 tons of bamboo pulp a month, and the capacity can easily be enlarged to 600 tons a month.

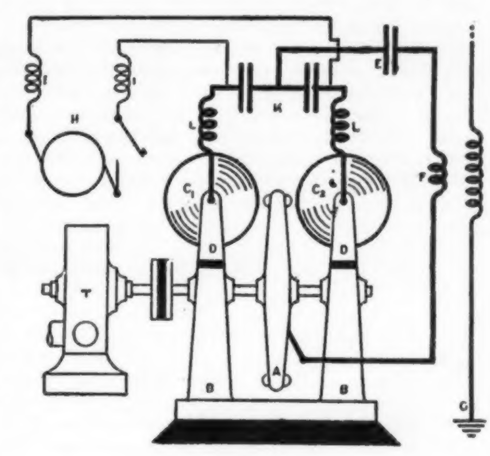


FIG. 22.

The making of paper from bamboo is not a recent discovery. For generations the Chinese have carried on this industry in their homes, but their methods are exceedingly primitive—no chemicals entering into their process. The Chinese use only bamboo shoots, for the evident reason that the shoots can be more readily worked up.

The new company will use all kinds of bamboo, young and old, but particularly a variety called "kei chiku," of which there is an unlimited quantity. The question of the supply of raw material will never puzzle the company, for the growth of bamboo is very rapid. It verily grows inches in a night.

The experiments so far have been made by mixing bamboo pulp and wood pulp in varying proportions, according to the quality of paper desired. But it is intended later to make paper entirely from bamboo pulp; the only difficulty standing in the way of that process now is that the cost of an entire bamboo paper is more than the cost of wood-pulp paper. It is expected that all the machinery of this company will be installed and the plant will be in full operation by June, 1910. The process employed will be a modified sulphite, specially prepared by the company from bamboo. There are eight different stages in the manufacture: (1) The preparation of the bamboo by chopping into small pieces from one to two inches in size; (2) cooking or digesting in a digester with sulphite of calcium; (3) washing with water; (4) bleaching with powder or electricity and washing again; (5) drawn through a machine to press into the form of web; (6) drying by steaming; (7) rolled by winding machine, or cut into sheets.

The pulp will be shipped to Japan in the form of rolls or sheets, where it will be manufactured into two grades of paper—news and book. On the Formosan pulp factory, and on the mills at Kobé, where the finished bamboo product will come forth, much interest will be centered by the great paper industries of the world.

At Haltem, in Westphalia, near the site of the Aluso fortress, erected by Drusus in the year 11 B. C., was recently found a bronze vessel containing a dried black mass, which Prof. Kassner has decided to be Roman ink. The mass was found to consist chiefly of soot and tannate of iron. It also contained smaller quantities of ferric oxide, copper oxide, clay, magnesia, gypsum, phosphoric acid, carbonic acid, alkalies, and sand. These ingredients probably represent chiefly accidental impurities which have found their way into the old inkstand, but some of them may be due to the chemical action of the ink on the bronze vessel. The presence of an aromatic substances suggests that the ink was imported from Italy, where the use of perfumed ink was common.

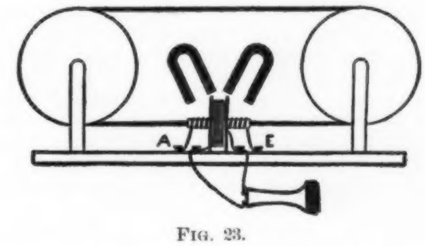


FIG. 23.

THE SEISMIC PERIOD OF 1909.

A CRITICAL CONSIDERATION OF RECENT EARTHQUAKES.

BY LIEUTENANT JOHN C. SOLEY, U. S. N.

The forces of nature are so tremendous that mankind stands impotent in the face of them, even when their operation is familiar; but, after the giant forces have done their work and the world has grown quiet again, the careful student may find a way to draw back the curtain from these terrible mysteries and elaborate the laws which govern the periods of activity and repose. The fundamental problem of such a line of research is to develop the causes which produce certain effects; there can be no effect without a previous cause, and no cause can act without producing its full effect. In this wonderful cosmos, nothing has been left to chance. The movements of the winds in the air, of the currents in the sea and of the constellations in the heavens, the ebb and flow of the tides, all are going on with such persistent regularity that laws have been deduced which govern their operation. But these phenomena continually present themselves under different aspects; the sun rises and sets, but never at the same time or place, there are alternate elevations and depressions of the sea but with a diurnal or semi-diurnal variation, the winds blow strong or weak under continually changing atmospheric pressure; nature is always striving for equilibrium, but the pendulum always swings back and forth. The strength or permanence of these variations always depends upon the underlying cause, and that cause is some force representing work done; but just as there is no mean force, so is there no regular work done. The processes of nature, which are ordinarily gentle in their operation, become violent at intervals, and the seismic forces are subject to the same phases of irregularity; the rhythmic principle is always evident in volcanos, whether they are throwing out bubbles of steam or rivers of lava, and in the earth waves, whether they are pulsing gently or striking blows of titanic force. The irregularity of the movements, however, shows that the cause must be subjected to periodic influences; therefore the first steps must be to group the possible causes and visible effects into periods and then, by allocation, elimination, or synchronism, to guess at the probable cause which can rouse the unseen forces into demoniacal fury or calm them into temporary suppression.

In the year 1907 solar flames and sunspots were observed on November 15th, and they were followed by earthquakes in Spain, Manila, Calabria and Turkestan; eruptions in Samoa and near the Cape Verde Islands.

In the year 1908, an immense sunspot was observed on September 12th, with auroras and sky glows, followed by earthquakes at Hilo, Vancouver, Manila, Guayaquil, Argentina, with eruptions at Kilauea and Chili, culminating in the great disaster at Messina.

In the year 1909, seismic events have occurred as follows:

January.—On the 9th and 10th, nearly simultaneous earthquakes in the Canaries, northern Italy, Acapulco, near Seattle, and the cable broken 175 miles from Seattle. On the 20th and 21st, shocks at Andalusia, Smyrna and the Ionian Isles and a great eruption in Luzon. On the 23rd a violent earthquake in Southern Persia. Seismic sea waves on the coast of Northern California to British Columbia and in the North Atlantic.

February.—On the 10th, eruption of Colima; earthquakes, 11th, in Southern France; 13th, Messina; 16th, Asiatic Turkey; 17th, Portugal, Smyrna, St. Thomas, Porto Rico, Andalusia, and a coal mine explosion at New Castle, England.

March.—Violent eruption of volcanoes of Colima in Mexico and Izalco in Salvador; earthquakes few in numbers did little damage; 23rd, sunspots.

April.—Colima in eruption; 23rd, earthquakes, Iberian Peninsula; 26th, earthquakes and eruptions in the Kameruns.

May.—On the 7th, Lake Erie was disturbed by pulsations, causing an extraordinary rise and fall of the water at Buffalo, the water rising four feet above the normal and falling as much below; 17th, earthquakes in Peru and Chili, Spain and Messina; 26th, in Iowa, Indiana, Illinois and Wisconsin.

June.—On the 4th, earthquakes, severe at Singapore and destructive in Sumatra; 11th, a violent earthquake in Southern France and the Riviera, especially disastrous in Provence, and eruption of Mount Erebus; 23rd, shocks in Unalaska, California, Nevada and Chili; coal mine explosions in Pennsylvania; Teneriffe began to be disturbed.

July.—On the 1st, shocks at California, Kingston, Caracas, and Spain, with violent quakes at Messina and Reggio; on the 8th, the earth waves covered a wider area and were more destructive. Shocks were felt at Kingston, Port au Prince, Lisbon, Algeria, Tunis, with seismic sea waves, great waves in the North Atlantic; 10th, severe quakes in northern India and central Asia with coal mine explosions in Russia and Spain; 15th, shocks in Oceania, California, Lisbon, and southern Greece. The climax was reached on the 30th, when the Mexican plateau was visited by a number of shocks, causing much damage in Mexico city and in the cities of the State of Guerrero, which were all seriously damaged down to Acapulco, which was also visited by a great sea wave.

August.—On the 3rd, shocks in British Columbia, California, Brest, Lisbon, and Calabria; 14th, a severe earthquake in Japan, through the district which was devastated by earthquake in 1891; 15th, quake at Acapulco with a seismic sea wave along the whole Mexican coast; 25th, severe shocks through northern Italy.

September.—The early part of the month was quiet, except on the west coast of Mexico, where the great sea waves continued to do much damage. 15th, Kilauea became active; 23rd, 24th, 25th, sunspots appeared in numbers with brilliant auroras in the north and south. On the 25th a tremendous magnetic storm lasting nine hours paralyzed the cables all over the world, and it was of such intensity that earth magnets were more seriously disturbed than ever before. From the 23rd to the 27th, shocks were felt through Indiana, Illinois, Missouri, and Kentucky.

October.—Early in the month shocks were felt in Utah and there was a coal mine explosion in Washington, and then the earth was comparatively quiet until the end of the month. On the 23rd there was another magnetic storm, not as severe as the one in September, but it interfered with the operation of the Atlantic and Pacific cables and of many land lines. On the same day shocks were felt in Illinois, Missouri, Arkansas, Kentucky, Tennessee, Sicily, and Beluchistan; 26th, an unexplained disturbance occurred in the Gulf of Mexico near Frontera, which was thought to be volcanic, and at the same time a great sea wave swept in on the west coast. On the 28th there were severe shocks in northern California and southern Oregon and a great sea wave off Cape Mendocino. On the 31st there was a destructive coal mine explosion in Pennsylvania.

November.—From the 8th to the 15th a tremendous storm raged through the Greater Antilles, with electric storms and torrential rains. Submarine cables were affected all through that territory, and there were great sea waves at many points. A volcanic eruption began on the island of Tenerife which reached enormous proportions on the 25th and suddenly ceased on the 28th, when Vesuvius began to show signs of activity.

In this record certain facts stand out with striking clearness: (1) The most serious disturbances occurred between the 1st and 5th, the 15th and 20th, the 25th and 30th of each month; the worst ones were at the end of one month or the beginning of the next. (2) The great earthquakes occurred, January in Persia, April in the Kameruns, June in southern France, July in the Mexican plateau, August in Japan. (3) Volcanic eruptions occurred, January in Luzon, March and April, Mexico and the Kameruns; June, Mount Erebus; September, Kilauea; November, Tenerife. (4) Sunspots appeared in March, but they were most numerous in September, when the solar prominences were also observed with auroras; great magnetic storms occurred in September and October. (5) The west coasts of North and South America were visited by frequent sea waves, showing a general disturbance in the Basin of the Pacific. (6) The Middle West of the United States was disturbed by earthshocks in May, September, and October. (7) Local earthshocks began in Tenerife soon after the sunspots began to appear, and in November soon after the great magnetic storms the eruptions began on the western flank of the Peak of Teyde, and five secondary craters opened, discharging acid lava which quickly changed to basic, and the eruption ended almost as suddenly as it commenced.

The earthquakes, the volcanic eruptions, and the seismic sea waves of the last three years have all occurred at nodal points on the main line of weakness, but they were not confined to any one locality. The fact that they have occurred in so many different parts of the world at the same time indicates that some central point is the origin of the vibrations, while the synchronism between the electric storms in the sun and the magnetic storms in the earth point to a solar origin of the light rays, whose penetration is so intense that they can destroy the chemical equilibrium of the magma, and whose volume is so enormous that they can flood the heavens with light at the two magnetic poles.

In the terrible cataclysms here recorded, which are caused by the titanic forces of the inner world, the same powerful agent sets the forces in motion, controls their action, and quiets them again. Volcanic eruptions are not matters of chance; they are movements of the elements obeying the laws of nature. Vibrating earthwaves are no accident; they are impulses that are sent pulsing through the belt of the lithosphere under control of the same powerful laws and with the same rhythmical movement that sends the sea waves vibrating through the hydrosphere. The days, the hours, are fixed throughout the universe when something shall be accomplished as well as the rhythm by which the movements are regulated. All of these wonderful operations of nature are parts of the evolution of a period in which they bear to each other a certain definite relation.

The natural laws which govern the chemical reaction of the magma of the interior are so well known that there can be no uncertainty about the results. It is known that chlorine, fluorine, oxygen, hydrogen, silicon, carbon, sodium and sulphur can unite only in certain ways and with certain results. It is known that the lavas, of which so much has been written, have always the same chemical components, differing only in the proportions which make one acid and the other basic, and that sometimes the discharge of one volcano changes during an eruption from acid to basic. It is known that some volcanos emit hydrochloric, others hydrofluoric, and others hydrosulphuric acid gas. It is known that the gases, the slags, and the bubbling steam must result from the reactions of the magma as surely as they do in a blast furnace or in a laboratory.

Now if the natural laws are so exact in regard to the chemical reactions they must apply with equal exactitude to the times when they shall take place. Owing to the fact that seismic disturbances are recurrent phenomena, the time factor is most important in determining their sequence; but the rhythmical movement is sometimes complicated and sometimes regulated by mechanical or chemical conditions, causing alternations in the rhythm, passing from periodic to non-periodic fluctuations. We may concede that certain effects will ensue from certain causes at certain times, but there is generally an external stimulus which has a mechanical effect on the cause, resulting in rapidly changing periods. There is also possible an infinite variety in the production of vibrations due to the relative chemical intensity of the composing forces, and this phase is an important factor in determining the periods. Many of the movements which appear to be non-periodic are merely complex, and though apparently irregular, it will generally be found that the components are periodic and often the entire rhythm turns out to be periodic.

From a mechanical point of view, seismic movements all have a definite object in relieving the interior of the earth from the accumulated products of combustion, gas or slag, due to the chemical reactions, and this offers a logical reason for the changes from periods of rest to periods of activity. Judging by the enormous quantity of material thrown out by volcanoes in eruption and by the tremendous accumulation of gases escaping at the same time, a certain amount of time must be necessary for recuperation. During this time the reactions in the magma go on under normal conditions and there is no outbreak, probably because there is plenty of room for the accumulation of gases and of slag. There are always minor explosions of gas which send tremors through the crust, and there are always the continuous volcanos relieving the pressure, but the explosions gain in force and intensity as their locus become more confined, reaching a climax when there is no longer any space inside and they must find a vent.

From a chemical point of view, reasons also appear which make for periodic changes. The processes of the magma are those of decomposition or degradation to simpler forms and they involve a constant state of change, which state is followed by variations in the gas pressures. The oscillations of the high and low pressures of the interior, with corresponding changes in temperature, exercise a controlling influence on the chemical reactions which follow any

changes in equilibrium. There is never an even distribution of temperature or pressure, because the properties involved are going through a continuous series of chemical changes in passing from one element to another; as the chemical activity is greatest at the beginning and end of a series, we may look for two periodic variations in each series, repeating themselves at fixed intervals; but, as the series of chemical changes is practically continuous, non-periodic or accidental variations may be expected of varying duration and extent.

In addition to the mechanical and chemical reasons for the periodicity, we find others by going back to the prime cause of all seismic activities, the sun. The liberation of hydrogen gas on the sun is the cause of the solar prominences and sunspots, and the liberation of hydrogen gas on the earth is the cause of the earth's eruptions and quakes. The connecting link between the two is the radio-activity of the sun, which intensifies both the electrical energy and the magnetism of the earth. Whenever or wherever the solar energy can be most directly transmitted to the earth as electrical energy, the force developed disturbs the chemical equilibrium of the magma and sets all the forces in motion. The imprisoned gases begin to explode, and the earth storms drive as violently through the crust as the hurricanes drive over the surface, while there is absolute agreement in point of time between the periods of the sunspots and the periods of active vulcanism on the earth.

A seismic period contains electric and magnetic storms, sunspots and solar prominences, earthquakes and eruptions. The first explosion of a period sets the earth waves in motion. The chemical reactions commence; the heavier minerals, separated from the silicon, are precipitated and the slag, permeated by the steam, becomes liquid enough to flow. The hydrogen cuts its way through the channels of the old fissures.

New gas explosions send sets of waves vibrating through the crust along the lines of weakness, which reach the surface in different parts of the world almost at the same time but far from the immediate influence of the impelling force. If volcanoes are opened in different parts of the world to throw off the slag and gases, the tension of the gases is relieved; but if there is no such relief the gases thunder back and forth, weakening the crust by their vibrations, until, at some point weaker than the others, the crust gives way, and there is a cataclysm which shocks the world. No eruption, no earthquake, is an instance of individual action; the roar of a volcano echoing over the world or the crash of an earthquake shattering a city is but the monotone of a period.

THE EVOLUTION OF THE BRAIN.*

THE ORIGIN OF NEOPALLIUM.

AS THE result of the investigations carried on in the Museum of the Royal College of Surgeons during the last seventy-five years by its conservators and those who have drawn their inspiration, directly or indirectly, from the work done in the museum, it has become possible to establish on a firm basis the criteria for instituting exact comparisons of the structure of the brain in the various groups of vertebrata.

This analytical work has now been carried far enough to justify us in attempting a synthesis of our knowledge of the evolution of the cerebral cortex. The special aim of such a research is to investigate the nature of the factors and the circumstances which have brought into being the neopallium, the part of the nervous system which, more than any other, is responsible for the kaleidoscopic manifestation of psychical activities, and the possession of which has made the Mammalia what they are, and given them the dominant position in the animal kingdom.

At the very root of the vertebrata we find that petromyzon has a cerebral hemisphere no larger than the olfactory bulb of which it is little more than an appendage. Direct nerve tracts pour smell-impressions into almost every part of the surface of this hemisphere. The cerebrum at its commencement is thus almost purely an instrument for the reception and the conscious appreciation of stimuli evoked by odoriferous particles, and, in the second place, for providing the means whereby the physiological processes underlying this state of consciousness may affect the rest of the nervous system, and through it influence the behavior of the lamprey itself. It is just possible that even in this lowly vertebrate gustatory fibers brought up to the lobus inferior (of the fore-brain) from the terminal nuclei of the seventh and ninth nerves may make their way into the primitive cerebral hemisphere, but it is still uncertain whether the lobus inferior itself may not be the place where impressions of smell and taste meet.

Even in Petromyzon there is some indication of a differentiation of the hemisphere into a superficial cortical layer (tuberculum olfactorium) and a deeper ganglionic part (corpus striatum), and there is also some slight trace at the extreme dorso-mesial edge of the presence of a small rudiment of the pallium. The tuberculum olfactorium in the Selachii assumes a definite cortex-like arrangement of cells, and is now recognizable as one of the receptive apparatus for olfactory impulses coming directly from the olfactory bulb. The corpus striatum does not receive any direct olfactory fibers; it is the part of the hemisphere which receives afferent fibers from the tuberculum olfactorium, and possibly also from more caudally situated regions of the brain—almost certainly gustatory fibers from the lobus inferior—and it emits efferent fibers, which pass to the hypothalamus and indirectly influence the executive mechanisms of the body, i. e., its functions find expression in the behavior of the animal.

In some of the Selachii the dorsal part of the hemisphere is definitely transformed into a cortical area or formatio pallialis. In Petromyzon there is still room for doubt as to the existence of any such structure, but when we turn to the study of the brain in some of the sharks there can be no doubt of the existence of a considerable area of primordial pallium. There is every reason to believe that this pallial formation represents the undifferentiated rudiment of the whole pallium of the higher vertebrates. Its mesial edge ultimately becomes specialized to form the hippocampus, which in the higher vertebrata does not receive smell-impulses directly from the olfactory bulb, but indirectly through the intermediation of the olfactory peduncle and tuberculum olfactorium on the mesial side, and of the pyriform on the lateral side. The lateral edge of the pallium eventually develops into the pyriform lobe, which continues to receive olfactory impressions direct from the bulb. Much later on, only, in fact, when the mammal appears on the scene, the pallial area intervening between the hippocampus and the pyriform lobe becomes specialized to form the neopallium. It is only right to say that this view of the nature of the primitive pallium differs fundamentally from the various interpretations now being urged by other biologists.

Putting aside the condition of affairs found in all other Ichthyopsida, the consideration of which would be confusing unless there were time to discuss their morphology in some detail, let us look for a moment at the brain of the Dipnoi. In the mud-fish the cortex-like material forming the tuberculum olfactorium becomes highly specialized and forms a relatively enormous organ upon the basal aspect of the cerebral hemisphere of which it constitutes more than half the bulk. The pallial formation also becomes more distinctly differentiated into a cortex, the lateral part of which can now be justly termed "pyriform" and the mesial "hippocampal." The fornix-fibers connected with the latter are embedded in a mass of ganglionic matter—the paraterminal body—which exhibits a functional relationship to the hippocampus analogous to that which the striate body presents to the other cortical areas. In other words, it is a nucleus of origin for large numbers of projection fibers which pass down to the hypothalamic region, and the cells of origin of these fibers are probably under the influence both of descending hippocampal (smell) fibers and ascending tracts from the lobus inferior of the hypothalamus (probably taste).

Leaving the Amphibia out of account, and turning at one step from the Dipnoi directly to the reptiles, it will be found that the highly developed tuberculum olfactorium of the Dipnoi has undergone a great diminution in size and an even more pronounced deterioration in structure, but the corpus stratum and the pallial formation show a great advance both in size and in specialization of structure.

There are very definite reasons for rejecting the views of Ramon y Cajal as to the homology of the mesial wall of the reptilian hemisphere, and also von Kupffer's identification of the hippocampus. Nor can we accept in its entirety the interpretation of the limits of the hippocampal formation and of its constituent parts favored by Edinger and Ariëns-Kappers.

The hippocampal formation of the reptile is not broken up into two parts, fascia dentata and hippocampus *sensu stricto*, as it is in the mammal, but is a continuous column of cells, as the lecturer pointed out in 1895—an opinion since confirmed by Giuseppe Levi.

But there is no fully differentiated fascia dentata in reptiles as Levi believes. The hippocampal formation of a lizard contains cells analogous to those of the fascia dentata intermingled with others like those of the hippocampus sensa stricto, and others, again, intermediate in structure between the two. Thus in the reptile the hippocampal formation is caught, as it were, in the act of differentiating. Ultimately (in mammals) all the hippocampal cells vanish from its mesial part, leaving only "dentate" cells, which form a receptive organ for incoming olfactory impulses, and the lateral (dorsal) part of the formation loses all its "dentate" cells and becomes a purely associative and projection organ.

In reptiles the larger size of the corpus striatum and pallial formation is probably related to the fact that many sensory fibers ascending from the optic thalamus make their way into the hemisphere. The researches of Edinger, Wallenberg, Gordon Holmes, Ariëns-Kappers, and others, have made it appear most likely that these fibers carry tactile impressions from the tongue and the cutaneous areas around the mouth, and possibly also visual impulses.

These two categories of fibers are certainly abundant in the peculiarly aberrant and highly specialized brain of the bird, in which the corpus striatum takes on an enormously enhanced importance and significance, and develops along lines which diverge widely from the stream of mammalian evolution.

In the reptile there is no true neopallium, but great confusion in the relations is produced, because the lateral part of the pallial formation is being suddenly stimulated to expand by the entry of these sensory, and perhaps visual, fibers. The rapidly overgrowing cortex becomes bent into the ventricular cavity to form a pseudo-ganglionic (but really cortical) mass, which Edlinger has called Epistriatum.

In the immediate ancestors of mammals the number and variety of sensory paths which found admission into the cerebrum became enormously increased, and led to a further specialization of the pallial formation, resulting in the birth of the neopallium—a cortical area where all the sensory impulses brought to the cerebral hemisphere along these new channels might be received, be blended in consciousness with those coming from other sense-organs, and leave impressions which might be stored, as it were, in this neopallium, and so influence other sensations and states of consciousness at some subsequent time. The neopallium is thus the organ of associative memory.

It is, perhaps, not devoid of significance that the first appearance of a definite neopallium coincides with the transformation of the skin over the whole surface of the body into a highly specialized tactile organ.

The further evolution of the neopallium in the Mammalia, and the formation of sulci and convolution, was also discussed, special stress being laid upon the value of the unrivaled collection of brains in the college museum for the study of this aspect of the subject.

* Summary of Three "Arris and Gale Lectures" on "Some Problems relating to the Evolution of the Brain," delivered in the Royal College of Surgeons on December 13, 15, and 17, 1909, by Prof. G. Elliot Smith, F.R.S.

MOST of our readers are doubtless familiar with what are known as "Prince Rupert's drops." They are merely molten glass which has been allowed to drop into cold water and thus to cool rapidly. As a result of this sudden chilling the drops are under such great molecular strain that, by breaking off the tail, the entire drop is reduced to powder. The internal energy of one of these drops has recently been worked out by K. Lerp. In his investigations he assumes a Rupert's drop to be spherical and the tension identical on all sides. He deduces the value 4.38 gm.-cals. as a higher limiting value for the quantity of heat stored in the drop per cu. cm. By measuring the bending moment required to break off the point of the drop when the latter is supported on an edge, the value of r, the coefficient of resistance to bending is found to be 40.8-77.6, the latter value approaching that for hardened steel (80). There is doubtless a connection between the extraordinary hardness of the glass drops and the internal tensions or the energy stored up. Calorimetric measurements give the mean value 0.067 (0.060-0.073) gm.-cal. per gm. of the drop for the heat evolved on breaking the drop. The specific gravity of the drops, s_1 is 2.5111 (2.5104-2.5118), that of the glass before fusion, s_2, being 2.5261 (2.5251-2.5274); the expansion $a = (s_2 - s_1)/s_1$ has the value 0.006013-0.006070. The radial pressure necessary to produce stresses equivalent to those existing in the drops is 3819.5 atmos.

Correspondence.

SQUARING NUMBERS MENTALLY.

To the Editor of the SCIENTIFIC AMERICAN:

I have been for some time using a principle in squaring numbers, mentally, up to 500 or more.

As this principle may be new I shall take the liberty of submitting it, by first solving a couple of problems and then explaining the principle. We will take the numbers 512 or 500 + 12, and 486 or 500 — 14.

$$512^2 = (512 - 250) \times 1000 + \overset{12^2}{144} = 262{,}144.$$

$$486^2 = (486 - 250) \times 1000 + \overset{14^2}{196} = 236{,}196.$$

In explanation we will let x represent the number and E the difference between the number and its nearest hundred, fifty or whatever we wish to calculate from. Then we can form the following equation:

$512 + 12 \quad 512 - 12$

$(x + y) \ (x - y) + y^2 = x^2$ or

$\frac{1}{2} (x + y) \quad 2 (x - y) + y^2 = x^2$

$\frac{1}{2} (x + y) = 262 \ : \ 2 (x - y) = 1{,}000 \ : \ y^2 = 144$

Now suppose we wish to square 56 or 56 + 6.

$56^2 = (56 - 25) \times 100 + 6^2 = 3{,}136.$

Let $x = 56$ and $y = 6$.

$56 + 6 \quad 56 - 6 \qquad\qquad 56 - 25$

$(x + y) \ (x - y) + y^2 = x^2$, or $\frac{1}{2} (x + y) \times 2$

$2 \times 50 \quad 36$

$(x - y) + y^2 \ (x + y) \ (x - y) + y^2 = x^2 - y^2 + y^2$

which equals x^2.

Now suppose we wish to square 192 : $192^2 = 192 - (200 - 192)$

100 or $92 \times 400 + 8^2 = 36{,}864$.

Now suppose we wish to square 546 : $546^2 = (546 - 250) \times 1{,}000 + 46^2 = 296{,}000 + 46^2 : 46^2 = (46 - 25) \times 100 + 4^2 \ 46^2 = 2{,}116$. Then $546^2 = 298{,}116$.

This principle can also be used in extracting the square root, but not generally very advantageously.

I will only give one example. $\sqrt{262{,}144}$, by inspection we see that the first figure of the root is 5, then by dividing by 1,000 and adding 250 we get 512 as the square root, which we know is correct, as 144, the number remaining, is the square of 12. Of course, the greater difference between the hundreds and the balance of the number, the more complicated the problem becomes.

J. F. HEILSHORN.

Defiance, Ohio.

ACCURACY OF GAS-ENGINE INDICATORS.

THE accuracy of gas-engine indicators was investigated by Prof. Frederic W. Burstall, M. Inst. M. E., in recent comparative tests of an optical and a spring indicator. A paper describing these tests was presented at the Liverpool meeting of the Institution of Mechanical Engineers, July, 1909. A Hopkinson optical indicator and a Crosby spring indicator were connected to the two branches of a special Y-shaped fitting so that both indicators were at the same time subjected to the pressure in the engine cylinder. The cylinder of the engine had a diameter of 16 inches, with 24-inch stroke and a speed of 165 R. P. M. Cards were taken simultaneously with four different regulations of the amount of gas admitted, giving mean effective pressures ranging from 78 to 103 pounds per square inch. Mean diagrams for each regulation were then plotted for each indicator by averaging the ordinates of twelve or more separate cards and the mean diagrams of the two indicators for each regulation were superimposed one upon the other in order to compare them. The compression lines were found to be practically coincident within the error (1.4 pounds per square inch) of measuring and plotting the diagrams. The maximum pressures practically agreed in two of the four tests; and in the other two the Crosby indicator gave the higher indication in one and the Hopkinson in the other, the difference being about 4 per cent of the total initial pressure. On the expansion curve, the two indicators agreed for the first third of the stroke, after which the Hopkinson gave a higher expansion line, resulting in mean effective pressures about 3 per cent higher than given by the Crosby. Prof. Burstall was of the opinion that neither friction nor inertia was likely to account for this persistent difference between the two expansion lines, but was inclined to attribute it to a slipping in its support of the flat, bar spring of the optical indicator. His conclusions are as follows: The results of these comparisons while not an absolute proof of the accuracy of either of the indicators, is still strong evidence that both are giving results very close to the truth. . . . In the optic indicator the inertia is certainly negligible; that the two give results agreeing to within 3 per cent of the mean pressure and very nearly the same figures for the initial pressure, is good presumptive evidence that when either indicator is used with the precautions which have been described [The use of steel wire and phosphor-bronze stranded wire to replace indicator cord and the use of a heavy spring to control the tension in the wire.—ED.] the results so obtained are at least as accurate as any other measurement made in engine testing.—Engineering News.

SCIENCE NOTES.

Not the least important of the works of science is its effect in the promotion of general peace. As the nations are more closely linked together by the means of transportation and communication, their interests become more nearly alike, and they do not easily plunge into wars. The applications of science to war have at the same time made it more terrible and deadly, so that nations do not dare to expose themselves to the chance of physical or commercial extermination thereby involved. If the development of the aeroplane shall make it possible for a fast cruiser like the "Lusitania" to be sent out equipped with rapid flying machines which, on catching the strongest battleship shall make it possible to sail over her at too great a height to be shot at, but near enough to drop high explosives that shall destroy her, war will be at an end. The late Edward Atkinson once stated that all that was necessary to end war was the invention of a gun that should pick off generals at headquarters as the Boer sharpshooters picked off the British captains and colonels.

An English commission, which was appointed to investigate the fisheries of the North Sea, has published a report of experiments undertaken for the purpose of tracing ocean currents at great depths, which have no relation to the surface currents directly above them. A very simple apparatus, invented by Bidder, was used. A sealed glass bottle, resembling a soda-water bottle, but strong enough to withstand a very great pressure was dropped into the sea. The bottle contained sufficient air to make it float, but it was sunk by attaching to it a copper wire, of weight just sufficient to overbalance its buoyancy. When the end of the wire touched the sea bottom the bottle was relieved of part of its weight and remained suspended within a few inches of the bottom. In this condition it was carried along like a balloon on a drag rope, by the deep ocean current. Each bottle contained a request to the finder to return the bottle to a certain address, with the date and place of finding. Twenty per cent of the bottles launched were recovered. Some were caught in fishing nets and others were stranded on the shore.

Mathematics is probably the most misunderstood of all the sciences. Huxley called it "that science which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation." To this a sufficient answer might be that she does not need to, but a better one is that it is not true. Intuition and induction have a great part in all mathematical discoveries, as all of the great mathematicians agree. Mathematics has no subject matter, but may be applied to anything that has exact relations. To sing the beauties of mathematics to those ignorant of that subject is as futile as to praise music to the tone-deaf, or painting to the color-blind. The president of a great eastern university has said that the manipulation of mathematical symbols is a mark of no particular intellectual eminence. Presumably he had never tried it. To the often-repeated charge that mathematics will turn out only what is put in we may reply that while from incorrect assumptions it cannot get correct results it has the power of so transforming the data as to reveal to us totally unexpected truths. Witness the magnificent generalizations of Adams and Leverrier, of Hamilton, and of Maxwell. There is no doubt that the invention of the infinitesimal calculus has furnished man with the most powerful and elegant instrument of thought ever devised.

Gulleward, Hoag and Regnier have described a method of measuring the quantity of water which escapes from the body through the lungs and the skin, and have published some preliminary results. In subsequent experiments, made in Paris, and again on Mount Blanc, upon three persons differing in age, height and weight, they obtained results which lead to the following conclusions: The loss of weight is less at high than at low altitudes. The loss of water is also less at high altitudes, doubtless owing to the influence of cold and reduced atmospheric pressure. The proportion which the loss of water bears to the total loss of weight is always smaller on the mountain than at the sea level. Hence, the increase in the number of red corpuscles in the blood, which is observed at great altitudes, is not merely apparent, and due to loss of water from the blood. The production of new red corpuscles appears to be the means by which the organism adopts itself to the rarefied air of high mountains. A study of the diminution of the quantity of urine at great altitudes was also made. Urinary analysis revealed a great increase in the proportion of incompletely oxidized nitrogenous matter. Hence the dysury of mountain sickness appears to be the symptom of a true auto-intoxication. There is, in fact, a retention of water by the organism, for the period of dysury, which continues during several days, is followed by a stage of profuse urination, a veritable urinary crisis, which marks the termination of fatal cases.

TRADE NOTES AND FORMULÆ.

Water-glass Mortar.—Mix 100 parts of dried s[and] with 3 parts of lime which has decomposed in the [air] and 2 parts of powdered chalk or limestone, [pass] through a sieve, and add 2 parts of soda-water-gl[ass] solution of 33 deg. Bé.

Marking Ink for Cases and Packages.—Boil 65 p[arts] of shellac and 65 of borax in 450 parts of water [till] the whole is entirely dissolved. Then add 65 parts [of] gum arabic and remove the boiler from the fire. [As] soon as the mass is cold, add water to 750 parts a[nd] enough pigment until the proper consistence [is] reached. Lamp black will make a suitable color[ing] material for cases, and red or white for packag[es]. The ink should be kept in glass or earthenware ve[s]sels; no other kind are suitable for this purpose.

Coating of Electro-deposited Iron.—A fluid for th[is] purpose can be obtained, according to Varrentrap[p], by dissolving 2 parts of green vitriol in 50 parts [of] water, mixing this solution with one of 10 parts [of] neutral potassio-sodic tartrate (Seignette salt) a[nd] adding 20 parts of aqueous ammonia. By using thr[ee] to four Daniell's cells or a similar battery, a ve[ry] beautiful coating of iron can be produced with th[is] fluid. Or dissolve 4 parts of green vitriol and 3 par[ts] of sal ammoniac in 30 parts of water.

Wax Varnish for Masonry.—Take 4,500 parts (4[½] liters) of white Dammar varnish, 150 parts (1[50] grammes) white wax, and 2,250 parts (2¾ liters) [of] turpentine oil. Carefully heat the wax in a boiler b[y] means of steam, so that it does not become brow[n]. As soon as it is melted, pour in the turpentine o[il] and allow to cool. When cold, add the Dammar va[r]nish. If the varnish is too bright when dry, increa[se] the quantity of wax. First prime the wall with th[e] oil, then apply four coats of paint, smooth, and final[ly] apply the coating of varnish.

Casting for Gilding, Reissing's.—This consists o[f] gypsum, chalk, and glue; but it requires from six t[o] eight hours to harden sufficiently to admit of bei[ng] removed from the mold. Efforts have been made t[o] overcome this disadvantage by adding alum and suga[r] of lead, but no appreciable results have been obtaine[d] by this means; on the other hand, a rapid hardening can be produced by using potassium sulphate, potas[s]sium bisulphate, or potassium carbonate, and particu[]larly chrome alum. The same effect can be produce[d] by lining the molds with gauze or linen steeped in [a] solution of the above salts.

Wax Powder.—To prepare wax powder, cut pur[e] yellow beeswax into very thin laminæ. Spread th[e] latter on a plate, well protected from dust, and leave them for eight or ten days at the ordinary tempera[]ture of a room till all moisture has dried off. The older the wax, the more rapidly does it dry, a some[]what longer time therefore is needed for fresh wax. Then pulverize an equal weight of entirely dry rice starch in a porcelain grinding dish with a rough rub[]bing surface, gradually adding the wax chips. Care must be taken not to rub too rapidly or to press too hard while rubbing. Any portions adhering to the sides or to the pestle must be removed with a sharp spatula. All heat must be avoided; the rubbing proc[]ess is best performed at a temperature of 50 to 60 deg. F. Pass the powder through a fine metal sieve and keep it in a closed glass vessel in a cool place.

Washable Drawing Paper.—This is prepared in the following manner: Take any kind of paper, and lightly prime it with glue, or some other binding me[]dium adapted for the purpose, mixed with a finely powdered inorganic substance such as zinc-white, chalk, lime, heavy-spar, etc., as well as with the color chosen for the paper. Then coat the paper treated in this manner with water-glass mixed with a small quan[]tity of magnesia, or dip it in the mixture and allow it to dry for about ten days at a temperature of about 77 deg. F. Such paper can be written or drawn upon with pencil, chalk, colored pencil, crayon, charcoal, India ink and lithographic chalk and partly or entirely washed clear again twenty times or more with a wet sponge without undergoing any essential change. It makes a good substitute for school-slates, etc.

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